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Engineering News-Record

New Light on a Basic Problem

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"Lost Time in Construction"

HERE IS A DISCUSSION of a problem which forms the very basis of the construction industry—*how to get more work done.* The series deals with Methods, Machinery and Men. It has a direct appeal, therefore, not only to contractors, but to engineers and manufacturers of construction plant and materials.

CHARLES S. HILL, who wrote the articles, has drawn for his material upon a fund of thirty-four years of intimate contact with construction—he joined the editorial staff of *Engineering News* in 1888. His observations and conclusions, boiled down to essentials, represent thousands of miles of travel, trips to jobs from coast to coast, and interviews with contractors, construction superintendents, engineers and equipment manufacturers by the hundreds.

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

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Another Lesson for Pier Designers

DESTRUCTIVE fires in shipping piers occur with disturbing regularity. There are no statistics available, but considering the comparatively small number of such piers it seems probable that the fire loss per square foot area is greater in this type of structure than in any other. And yet there are few such fires which could not have been prevented by the observance of simple rules of design and protection taught at great expense in the fires of recent years. The New Orleans wharf, destroyed last month, was only another case in point. The negligence in design and protection are well pointed out by Major Shaw in his article on another page. It is only to be hoped that the next engineer who comes to design a wooden pier will appreciate first, the ease of conflagration spread in the wide open pier; second, the inflammable contents of the ordinary pier warehouse, and third, the tendency of any shipping pier to become unapproachable from shore by fire fighting apparatus. These may lead to a better layout, a more fire-resisting construction and a more efficient supervision than the New Orleans pier exemplified.

An Abiding Problem

AN UNFORTUNATE corollary of the coal miners' and shop-men's strikes is their overshadowing effect on the public mind as it contemplates the problems of the railroads. Even the man in the street knows that one result of the shop-men's strike is a deterioration of motive power and rolling stock. He understands also that an effect of the coal strike is to throw on the railroads a heavy traffic in that commodity just as crop movements are coming to their maximum. The tendency will be, therefore, to ascribe whatever transportation difficulties may develop during the next few months to the effect of the strikes and to overlook the fact that even without these additional griefs, our transportation system could not possibly be up to par. Early last spring the opinion was expressed in well-informed quarters that in the event of a business revival the roads would not be in shape to perform their mission. Deferred maintenance had taken its toll of the railroad substance and it was generally recognized that if the roads were to meet the demands upon them we must rely upon the skill and sustained devotion of the maintenance and operating forces. We cannot afford to forget that the inadequacy of our railroad facilities results from conditions that lie deeper than the recent strikes and that find their roots in our national attitude toward transportation enterprise. Short-sighted and vote-serving labor policies, undiscriminating rate-adjustment both downwards and upwards, punitive regulation inspired by abuses of an earlier day, dalliance with government operation; all have had a share in bringing about these conditions. But if the American people expect ever again to enjoy a transportation service that will be sound in itself and properly articulated with the rest of their industries, they must be governed by their present and prospective needs rather than by ancient grievances and political expediency. If American industry is to be kept healthy and vigorous we must guard against hardening of the transportation arteries; but without an earning capacity attractive to new capital the railroads cannot possibly keep pace with expanding requirements.

Encouraging Gambling

AN IMPARTIAL owner and non-collusive bidders are equally necessary to the sealed bid system of doing construction work. If either element is lacking every interest would be better served by open auctioning of contracts or by arbitrary selection with any system of payment that can be agreed upon. By common consent and by statute collusion among bidders is prohibited but if a growing complaint among contractors is a sign, the owner who uses the bids merely to play the bidders one against the other is becoming all too common. The latter evil takes the form generally of minor revisions in the proposals after bids are opened and the calling of new bids in the hope that knowledge of all the bids will bring about price shaving. In private work, at least, this is quite legal. Its ethics are a bit shady, however, and certainly it is most injudicious and dangerous. It introduces by subterfuge a gambling and speculative element into business which by its very nature has already too much financial hazard. Contractors in various parts of the country are making organized fights against specific instances of this practice and in these fights they should have the assistance of engineers, who appreciate that any method of letting work which imperils a fair price for a good job leads to degeneracy of the whole construction industry, of which they are a part.

Breaking Through Class Walls

CHARACTERISTIC of much present-day discussion on economics and social problems is the practice of dividing all humanity into a few general classes, each conveniently tagged with a word or a phrase that soon becomes a fixed and definite symbol. Among such tags are "labor," "capital," "producer," "consumer," "the public" and "the interests." These are legitimate words and so long as the meaning ascribed to any of them in a specific discussion is kept clear no fault can be found with those who use them; but a moment's reflection will demonstrate how impossible it is to effect so arbitrary and clear-cut a classification of human kind. Too often, however, these labels are applied deliberately to work up fictitious distinctions for political or less worthy purposes. Now and then we encounter an influence that tends to counteract this false gospel but too seldom is its significance made clear. One of these is the growing practice of producing firms to have their consumers for security holders. This works to bridge the gulf between the "producer" and the "consumer." When the producer happens to be a public

utility, it tends also to dim the distinction between "the public" and "the interests." A variant of this is the placing of securities in the hands of employees, one effect of which is to show how shadowy is the line between "labor" and "capital." All this is worth-while and promising and there is room for more of it. It is not, of course, a panacea. Probably the day never will come when there will no longer be clash of interest between individuals and groups. But the life of a growing and prosperous people will be found in the normal interplay of these interests, and progress will arise from general compromise with respect to conflicting viewpoints.

Capacity a Factor in Water Power Value

MANY problems involving the determination of the value of hydro-electric power to an operating power system or the comparison of one hydro plant with another power plant, hydro or steam, can not be solved satisfactorily without taking into account the factors both of capacity, the essential elements of which are the prime-mover equipment and the water supply, and energy, which is the name given the quantity of work done by the water through the hydro-electric equipment.

The usual practice in evaluating hydro-electric power has been to reduce annual charges, fixed and operating, to cost per kilowatt-hour, the unit of energy. This is the easiest thing to do, but to use such a cost for purposes of comparison is misleading except under the rare circumstances when the plants under comparison have exactly the same pertinent characteristics. The best example of a valid use of this simple method would perhaps be a comparison between the costs of output from two plants utilizing Niagara River water and head.

Ordinarily, however, there are important variations. For example, excepting Niagara conditions, there are hardly two hydro-electric plants which do not differ in such important respects as distribution of stream flow throughout the year or series of years, ratio of installed hydro capacity to average stream flow, available storage, etc. Evaluations in terms of cost per kilowatt-hour of output usually take into account the difference between primary and secondary energy, that is, between the energy resulting from that stream flow which is reliably available for carrying a given load for X hours per day or Y hours per week, year in and year out, and that which is only intermittently available. But even with the factor of variation in stream flow thus taken into account the story is incomplete without likewise taking into account *capacity*.

The effect of capacity may be noted in the difference in cost in providing for the generation of a given average quantity of hydro energy per year on a high load-factor, or machine-factor, basis, as compared with a low load-factor basis. Although the difference, taking fixed charges into account, is not so great as in the case of steam-electric plants, yet even in the case of water power 70 per cent (high) load-factor energy may cost only two-thirds as much as 40 per cent (low) load-factor energy. This results from the fact that the cost of the additional equipment, installed solely because of low load-factor conditions, must be distributed over the same number of kilowatt-hours as the lesser equipment. The difference in cost is the more marked in the cases of indirect hydro-electric developments where pipe-line, canal or tunnel capacity must be increased to correspond with power house machine capacity.

The converse effect is found in that class of developments where storage reservoirs are essential for stream flow regulation and where, consequently, the greater the extent to which dry season flow is augmented from storage, the more costly the development as a whole. If, in such a situation, a fixed machine capacity be assumed, the cost per unit of energy output will be less for the lower load-factors—referring now to the load-factor of primary energy.

Even more necessary is it to take capacity into account in comparative studies of prospective steam and hydro plants intended to do the same work. Steam-electric units can turn out energy in an amount and continuity limited only by periodic inspections and repairs, whereas the output of hydro units is ordinarily limited by the available stream flow. But this is only one of a number of factors involving capacity. Assume the case where the problem is to determine whether hydro or steam power should be added to a large system in order to provide increased capacity to take care of market demand. The state of the art is such that transmission lines no longer are a bugaboo. In fact extensive steam-electric power systems in New England, New Jersey and other parts of the East are already dependent on transmission systems to practically the same degree as if the territory were served in whole or in part by hydro power. The reliability and flexibility of a well-designed hydro station is now generally admitted to be superior to that of an equally well-designed steam station, so much so in fact that this superiority may properly be offset against possible weakness in the transmission link. Here evidently the problem is not properly solved unless one takes into account, not merely the cost of fuel and labor and the other items entering into the so-called operating cost of producing energy, but also the fixed charges, such as interest, depreciation, taxes and insurance, against the capacity by means of which that energy is produced.

The necessity of evaluating capacity is perhaps most clearly evidenced under circumstances where the hydro plant would be used as reliable peak-carrying capacity for a large power system. There the consumption of primary hydro energy would be minor in amount. If all costs were allocated to the kilowatt-hour, the unit cost of energy would be shockingly high. Indeed, to omit evaluating capacity in such a case would be little short of absurd.

The choice of proper terms for such an evaluation, of capacity as well as energy, is a problem in itself. Herein is suggested only the necessity for its being made. But it may be said that in its solution one should give serious consideration to the method of making comparisons in terms of equivalent steam-electric capacity, using the steam-electric capacity, so to speak, as a common denominator.

Road Building Hints From England

PENETRATION-MACADAM practice in Great Britain, as it is described on p. 564 of this issue, deserves notice in two particulars of construction which are not often given such careful attention by American road builders. They are (1) testing an old road surface to determine its sufficiency as a foundation and (2) protecting the stone course from rain and removing rain water by means of driers, so that the penetration of the binder is assured.

British road builders instead of sounding the old macadam by an occasional test pit to determine thickness, dig a trench through the surfacing half-way across the street every 450 ft., first on one side and then on the other. While an isolated thin spot may escape disclosure by this thoroughgoing opening up of the old pavement, there is not much chance that any considerable stretch of over-thin macadam will remain undiscovered. As an example of the assurance demanded by English engineers as to the integrity and strength of their road foundations before they place an expensive surface, the procedure described is well worth regard in this country where, relatively, the pavement slab receives the most intensive study.

In constructing the penetration surface the English road builder also takes precautions that are not common in the United States. Penetration work is most successful always when the stone course is warm and perfectly dry. In fact it is almost impracticable if the stone is water-soaked or very cold. A rain storm ordinarily stops penetration construction until the layer of stone has dried out and this is often a slow process in cold weather. To meet this situation English engineers (1) protect the laid stone by covering it with tarpaulins, (2) dry out the stone layer by artificial heat applied by blowers.

Substantially similar methods are known to American road builders but in connection with other kinds of paving work. In concrete paving, movable canvas shelters for the finished slab are common. Again, in brick paving, heaters are used to dry out the joints so that the bituminous filler will penetrate properly. Both devices seem entirely capable of modification for use in protecting and preparing the stone course for penetration macadam, so that the binder can be easily applied. The fact that British engineers have found housing and drying to be economically practicable justifies at least some experimentation with them in this country.

Adding Days to the Construction Year

IN THIS issue begins a series of four articles that have a wide appeal to the construction industry. There are three essential agents in the work providing housing and public facilities—the engineer (with whom we couple the architect), the contractor, and the manufacturer of materials and equipment. Each of these agents has a vital interest in lowering the cost of work. The engineer has a responsibility to his client for costs; the overhead costs of the contractor will be lowered if he can do a greater volume of work; the continuity of the manufacturer's operations will reduce his overhead, likewise, and enable him to put his product at a lower cost into the hands of the contractor.

All past efforts of these three agents at increasing the volume of construction in a given season, except on large building operations, have been directed at increasing efficiency during the present operating time. Relatively little attention has been given to *methods of finding more time in which work can be performed.* An inquiry tending in this direction forms the leading article of this issue.

Nor has this failure to find more working time been due to a lack of recognition of the wastefulness of the industry's use of the working year. Contractors have known that out of the 300 days worked by most industries they were utilizing, except in large building operations, only about 100. Yet a most exhaustive search of the literature of the industry and an equally exhaustive inquiry among engineers and contractors have failed to disclose anything but a negligible amount of study of or progress in this important problem. Recently, however, the need for action has been keenly sensed.

The time is decidedly ripe for a courageous and concentrated attack. We still have relatively high construction costs and, with a large deficiency in construction, with a labor supply inadequate to the demand and permanently diminished by the restriction of immigration, we need to use the available labor and equipment to the utmost. Striking evidence that the subject is coming to the front is afforded by the repeated insistence, while the plans for the American Construction Council were forming, on the need for studies along these lines. In fact, when the Council gets well under way, it is to be expected that it will attack the problem vigorously.

Before results of a large order can be expected, we must, however, broadly educate the entire industry to the tremendous opportunity that lies in the utilization of time now utterly lost. The largest possible volume of public-works construction and housing at the lowest possible cost should be the stirring ideal of the construction trio—engineer, contractor and manufacturer.

It is with the hope of furthering this broad educational work that *Engineering News-Record* had Charles S. Hill, its associate editor in charge of construction work, devote several months of intensive study to the problem. He draws, too, on a life time of experience with construction work. The results are found in the series of articles which begin in this issue.

We fully realize that great progress in the desired direction will come not from isolated articles nor the action of individuals, but from a broad movement supported by the leading organizations of the industry. The engineer, through such organizations as the American Society of Civil Engineers, the American Association of State Highway Officials, the American Society for Municipal Improvements; the contractor, through the Associated General Contractors and its affiliated regional organizations; the manufacturers, through their organizations, must put committees to work within their organization and in participation in joint work with the other branches of the industry. But of that, Mr. Hill will have something to say following the concluding article of the series.

In stressing, however, the need for organized attack on this tremendous problem, we do not mean to absolve the individual from a personal responsibility. The engineer can show his client, or his employer in the case of public works, that it will pay to prosecute work in winter; the contractor can devise ways of executing work in cold weather and of protecting operations so that they will not be interrupted by mud and rain; the manufacturer, particularly of equipment, can develop devices which may be operated with good, or even full, efficiency despite the weather conditions.

It is for these reasons that *Engineering News-Record* believes that seldom has an effort been made through the pages of a technical journal that has a stronger demand upon the attention of the industry than the series by Mr. Hill. That it may stimulate thought, that it may bring home to every engineer, every contractor, every manufacturer and to all their organizations the opportunity that lies in finding more time in which to carry on construction operations is our high hope.

Lost Time in Construction—1

The Causes of Lost Time

Winter Hibernation, Weather Delays, Poor Service, Plant Faults and Inefficiency Cut Down the Construction Year to One Hundred Days Worked

By C. S. Hill
Associate Editor, Engineering News-Record

First of a Series of Four Articles

WASTED time is the crying evil of construction. Winter idleness; Sundays and holidays; rain, snow and mud interruptions; machine delays; transportation delays; labor turnover, inefficiency and strikes; accidents and sickness; frequent plant shifts; yearly reorganization of working forces; engineering delays; illogical practices in letting contracts, and hand-to-mouth planning of construction programs reduce the working days of the year to less than a hundred. In modern construction operations, structure, i.e., masonry walls, steel framework, road pavement, is being produced, on the average, on only about one day in every three or four calendar working days. Engineering construction is about 25 per cent, certainly not over 30 per cent, efficient in its utilization of time. Remedy of this condition is a task for nation-wide effort of engineers and contractors.

It is unthinkable that it shall not be undertaken, that the construction industry, second only to agriculture as the leading industry of the country, will rest under the imputation of being so extraordinarily wasteful of time that about the only comparable business is that of summer-resort hotel keeping. So completely nation-wide is the short-season practice of construction, so woven in is it with the customs of every locality, that reform is a labor for more than the national associations of engineers and contractors. It requires the participation of local engineering and contracting organizations to consider and solve the various problems as they exist in every section of the country: The situation as it presents itself for the consideration of engineering and contracting organizations in respect to each of the principal causes of lost time will be considered under the following heads: (1) Winter idleness, (2) rain and mud delays, (3) management delays, which include plant delays, service delays and delays of direction.

Winter Idleness—Generally, construction is discontinued from October to May of each year. Winter work is attempted to a considerable extent only in building construction, underground work and heavy excavation. Except emergency operations, other kinds of construction are rarely undertaken. In fact effort is made to keep construction operations down to amounts of work which can be completed in a working season. If a larger volume is undertaken, it is specified that certain operations shall be curtailed or else the contractor voluntarily curtails most if not all operations.

Cessation of construction in winter is prompted, of course, by the fact that cold weather, particularly frost, hinders certain processes, makes all work uncomfortable and, ordinarily, adds to the cost of construction. *The processes which are actually prevented by cold weather are few.* In most cases they can be carried out with some added discomfort and at more or less increased cost. Actually cost is the deciding factor. If the owner will pay, any sort of construction can be carried on in winter.

Generally owners have not been willing to pay for winter construction and it has not therefore been practiced. It has followed that both engineers and contractors have come to believe that physical difficulties and not disinclination to pay the cost stands in the way. Habit has developed out of practice and contractors are not inclined to work in winter because it requires an upset of habit.

There is a further reason. Construction is an exacting task for those who direct operations; regular hours are unknown and if difficulties arise long periods of continuous work and worry are required. After a crowded summer's work, construction managers frankly demand a season of comparative inactivity. The custom of not carrying on construction in winter has led the industries which supply construction materials—brick, crushed stone and gravel—also to discontinue or curtail production during the idle season. It is these last two facts which explain the practice of reducing winter construction operations in the Southern states where cold weather does not prevent activity.

In recapitulation, construction is not discontinued in winter because it is physically impracticable. It is discontinued because it costs more. This reduces the problem of extending the construction season through the winter months to one of economics. The truth of this assertion is indicated by the fact that wherever the value of winter construction is certain, means of carrying it on are found without especial difficulty. A similar readjustment of practice for the industry as a whole can be accomplished by showing, if it is the fact, that it pays generally to continue work in winter instead of letting plant and capital remain idle and the owners be delayed in getting the use of the improvement. This calls for concerted action. The individual contractor or engineer or owner can accomplish nothing in the nature of a general change at a cost which he can afford, but he can do something to improve his own practices.

It follows that the labor of reducing time wasted because no work is done in winter is put squarely on the organizations which represent the construction industry—on the engineering and contracting associations and on the manufacturers' organizations. The line of procedure to be followed is the only question for consideration. Investigations are obviously the first action. The following inquiries are needed:

1. Determination of the kinds of work which lend themselves to winter performance. (It seems practicable, for example, to install plant, accumulate materials and supplies and make everything ready for im-

mediate production with the beginning of warm weather even if actual building of some kinds of structures has to await the coming of warm weather.)

2. Determination of methods and equipment for conducting construction in cold weather, involving consideration of housing, heating of site and materials, substitution of machines for manual labor, etc.

3. Determination of costs of winter work compared with the cost of similar work in warm weather, which involves consideration of winter supply and wages of labor, ability to get materials, transportation service, reduction of unemployment, etc.

4. Determination of the limit where extra cost of winter construction ceases to be profitable; affecting the extra cost is the saving due to reduction of idle time of plant and organizations and of the time during which uncompleted construction is returning no service to the owner.

Rain and Mud Delays—Eliminating the winter period, October to May, as a problem for separate disposal in questions of weather delays, and counting out Sundays and holidays as economically justified for rest and recreation, the greatest causes of lost time in construction are rain and mud. In Arkansas in 1920, a very wet season, enough rain to interrupt road construction fell on 30 per cent of the calendar days, and in Iowa in 1921, a fairly dry season, counting working days only, about 15 per cent of the time was lost due to rain and mud. Probably these figures represent the minimum and the maximum of time lost in out-door construction because of rain and mud, considering, of course, the humid sections of the country where construction is most active.

Means of reducing time lost on account of rain and mud fall into the following classifications:

1. Moderating the engineering requirements for dryness, as of road subgrade, before continuing construction.

2. Employing methods and equipment the conduct and operation of which are least affected by wet weather conditions.

3. Employing methods of shedding rain or drying out surface mud.

4. Housing the work.

In none of these ways have engineers and contractors accomplished anything really constructive. Most of them have not given the problem the courtesy of serious thought, accepting rain and mud interruptions of expensive work as dispensations of Providence to be endured with Christian fortitude.

The practicable possibilities of the means enumerated are not imaginary. Certain methods and operations, as industrial railway haulage, are obviously less affected by wet weather than are others. Means of quick drainage, of shedding rain and of absorbing the mud layer have been tentatively demonstrated to be possible in road work, where, experimentally, finished subgrade has been crowned and tarred to shed water and in other instances has been spread with sand or stone chips to "soak up" the mud layer. Even housing, in the sense of tenting, offers possibilities.

Because it is one of the operations most hindered by wet weather and is the largest development of many years in engineering construction, highway construction suggests itself as a specific field for experimentation in methods of reducing time lost because of rain and mud. It is the one kind of construction whose direction is well centralized both nationally and by states and therefore the one kind which can most easily be brought under experimental study. The American Association of State Highway Officials is the body which should organize the inquiry in conjunction with the Associated General Contractors.

Plant Delays—Compared with time lost due to wet weather, plant delays are minor. Oddly enough, however, they, with service delays, have come to be thought of first when lost time in construction is mentioned. Lost time chargeable to plant is due principally to the following causes:

1. Poor co-ordination of the units of the plants;
2. Machine breakdowns;
3. Shifting plant units on the job, and
4. Inexpert plant selection, operation and maintenance.

The corrective to all these causes of delay is skilled construction plant engineering. In modern construction operations planning the plant layout and the selection, operation and maintenance of equipment call for mechanical engineering knowledge and resource well above that required in many factories and power plants where a mechanical engineer is regarded as indispensable. Such engineering direction, however, is not common in construction plants, even though plant investments on single contracts run from fifty thousand to half a million dollars.

Determination of the principles of plant layout and co-ordination and of the best practice in equipment selection, operation and maintenance is a task which the construction industry owes to itself the duty of performing. It includes the preparation of a system of recording machine performance and of keeping operating and maintenance costs. One need of such performance and cost figures is to provide the plant superintendent with data by which he can select and co-ordinate his equipment and plan his plant. The second need is to secure data which will disclose mechanical, structural and service weaknesses and indicate where and how improvements can be made. Standardization will be a logical result of such work.

Investigation of plant delays and of the means of reducing them is a joint task for the American Society of Civil Engineers and the Associated General Contractors. The last association has tentatively approached the task by listing standardization of equipment in its program of activities for the future. These good intentions should be clinched by the creation of special committees to inaugurate the work in a purposeful way.

Service Delays—Time is lost because of delay in delivery to the operation of a sufficient supply of materials to keep construction progressing with the continuity and speed otherwise possible.

A portion of this delay is due to failure of the producer to have ready for delivery the amount of material required at the time it is needed. Generally this sort of delay comes from the fact that the demand for construction materials takes the form of a peak load during the few months of active construction in summer and the capacity of the plant is unequal to this peak load. The producer meets the situation by accepting orders to the full volume of the demand and then jockeying deliveries among his customers so as to keep

complaint by any of them from becoming sufficiently violent to cause rupture of business relations.

The only cure which reaches the trouble fundamentally is some method of spreading the consumption over a longer period of the year and so smoothing out the demand curve to a nearer approximation of the curve of production. Some help may possibly be obtained through determining and publishing plant capacities or through the pooling of orders by a number of plants, but these are only palliatives. The remedy lies in spreading the demand by extending the production period. As this necessitates extending the construction season and co-ordinating transportation facilities with the demand, the problem is entirely worthy of the best talent that engineers, contractors and the producers can bring to its solution.

Another secondary cause of delay in the service of materials is engineering restriction of kind or quality, which limits the sources of supply and introduces long hauls, with, of course, correspondingly greater opportunities for transportation delays. The remedy here is research which will disclose safe methods of utilizing a wider variety of materials and then writing into specifications the modifications necessary to permit the use of these materials. An excellent example of this method of procedure is the investigation by the Iowa Department of Highways by which pit-run gravel from local pits is successfully taking the place in concrete road construction of material which, to meet the requirements of the older specifications, had to be imported. In discovering resources of this sort there is an unlimited field for engineering and contracting research work.

However, most of the service delays in construction are due to insufficient and irregular transportation. The railways at times do not and at other times cannot transport construction materials in the volumes wanted at the times needed. The reasons are many. There are physical limitations of line and equipment, there are preferential industries to be served, there are perishable or seasonal commodities which demand right of way, there are rulings of transportation governing bodies to be obeyed, and there is the paramount reason that when high-classification freight can be had, low-classification freight will always get the fag-end of the service. The problem to be solved is very intricate. To find the solution involves a study (1) in co-ordinating production, transportation facilities and demand, (2) in applying interstate and intrastate regulation, (3) in developing local supplies and (4) in developing other methods of transportation than rail.

Concerted action by all construction interests is required by the nature of the service delays which have been mentioned. It is wanted particularly because the individual industries, chiefly producers, are now seeking legislation which, while directed toward the eradication of a common evil, is naturally directed along lines most beneficial to specific interests. The construction industry and particularly engineers and contractors cannot evade the responsibility of leadership and they can secure it only through co-operation by their national organizations.

Delays of Inefficiency—Engineers, contractors, and workmen are all guilty of delays of inefficiency. The term is here restricted to the normal or routine duties of actual construction—contract practice, technical control, works management and fabrication.

1. Prevailing contract practice is responsible for an appreciable amount of lost time, although it is a minor cause.

Lack of uniformity, which compels changes in equipment and methods, and, under present conditions of winter idleness, late-season awards which continue the work into the cold weather or compel it to be carried over the winter, are recognizable causes of lost time. At present a joint committee of engineering and contracting associations is investigating the possibility of drafting and establishing uniform contracts. With progress made in its primary task, it is a logical action to make this committee a permanent body to develop improved contract practice.

2. Lost time is contributed by engineering interruptions.

Waiting for plans to be completed or to be changed wastes time. Another cause is waiting for finished work to be approved so that plant and organization can be shifted to new operations. Delays in inspecting and approving materials hold up progress. Bunching operations, as in highway construction, so that more work is concentrated in one locality than the producers of materials and the railway lines can handle expeditiously, is still another cause. Delays in turning in estimates and making payments; delays in approving contracts and in refunding guarantee deposits, and delays in rendering decisions and giving instructions are contributing causes of lost time.

Because none of these causes accounts for a long delay at any one time it is easy to pass them by without counting the aggregate of lost time which they represent. Greater expedition in the engineering operations attending construction would materially cut down lost time. In making this statement it is not forgotten that often the slowness complained of is the result of the too common practice of not providing adequate funds to maintain the quality and size of engineering organization required for prompt action. Other extenuating circumstances come to mind readily, but, in the end, reform lies with the engineering profession.

Hand-to-mouth planning of improvements is a prolific cause of lost time. Usually this is more a fault of administration and financing than it is of engineering. It is generally because he does not know in advance what money will be given him that the engineer plans for each appropriation as it comes along. The contractor has to equip and organize on the same basis; work speeds up as new appropriations are available and slows down as the money draws to an end; organization is built up and torn down. Federal river and harbor improvements furnish a notorious example of this manner of wasting time.

Delays of management are not all on the engineer's side. The contractor's manager by poor planning and faulty co-ordination of operations contributes heavily to lost time. These errors are not universal; the experienced contractor does not often commit them; they are no more common a fault in contracting than in any business, but so far as they prevail they are a condition to be corrected. The Associated General Contractors have this problem to work out through their committee on methods.

Labor turnover, soldiering, accidents and insubor-

dination interrupt work. Strikes and seasonal employment are major causes of lost time. These are all familiar factors of the great labor problem which confronts all business but they are mentioned to establish their place in the list of causes of lost time in construction. But while the great panacea for the inefficiency of labor waits on time to disclose, there are ills in detail which engineers and contractors can palliate by immediate action.

Yearly reorganization of labor forces results in time lost while the men are being trained to their individual duties and particularly in teamwork. Seasonal construction is the cause. Turnover seldom less than 30 per cent a month keeps a large percentage of the force always in training. Individual contractors are successfully reducing turnover and their methods call for study and expression. Accidents add to lost time not only because the man injured is out of service but because every serious accident sends some men away, causes others to lay off for a few hours or a day, and slows down all operations until the incident is forgotten. These are not imaginary effects. An entire blasting gang will often "quit work till after the funeral" because some powderman has received his reward for thawing dynamite at a bonfire. Large construction organizations find accident prevention profitable because it reduces lost time. Its extension calls for concerted effort by engineers and contractors.

Retrieving Lost Time—So much study has been given to methods of retrieving lost time that it seems to be forgotten that double shifts, night work, bonus wage payments, and the other devices of the "efficiency man" are not preventives of lost time. They help to utilize more efficiently only the time worked. *Methods of utilizing the time worked* have had intensive study while *Methods of finding more time for work* have been ignored. An examination of any of the volumes on "scientific management," or "management engineering," discloses this fact too clearly for any doubt. All these methods of increasing efficiency are time savers, as has been made clear, but they do not put more day's work into the construction year. This is the biggest task before the construction industry. It is a task which engineers and contractors must perform by organized action or stand convicted of being unfaithful to their opportunities.

It is not to be assumed that the construction industry has done nothing toward the improvements which help reduce lost time. The efforts have, however, been largely individual and the performances isolated. What value they have is ineffective because the results are not collected and analyzed. Concerted purposeful effort is now demanded. It can be made now with more chance of success than ever before because engineers, contractors and manufacturers are well organized nationally and locally and possess co-ordinating and advisory organizations such as the Associated General Contractors, the American Society of Civil Engineers and the American Construction Council.

The second article of this series—developing the problem of Winter Idleness in detail—will appear in the next issue.

Rectification of Rio Grande Through El Paso Valley Proposed

THE destructive floods which have occurred in Texas and in other states during the past year have caused the citizens of El Paso to investigate the flood problem with which they may be confronted and the El Paso Chapter of the American Association of Engineers was called upon to render assistance in the preparation of a report to cover the subject of river regulation and the possible remedies that might be applied in stabilizing and lowering the river channel at El Paso and through the lower El Paso Valley.

The city is located on the north bank of the Rio Grande at the head of the El Paso Valley, the lower portion of the city being on an alluvial plane of the valley and subject to danger from floods. In recent years there has been observed a progressive rise in the river bottom and in the water table in and below the city. Very moderate flood stages in the river have inundated certain areas threatening valuable property.

In 1915 the Elephant Butte storage reservoir of the Rio Grande Project was completed. This structure, located 120 miles above El Paso, has a storage capacity of 2,600,000 acre-feet. In addition to the function of providing irrigation supply during years of low runoff, it stores flood waters which, previous to its construction, passed down through the valleys and flooded large areas. The river below Elephant Butte Dam and El Paso, however, is subject to inflows from large arroyos draining approximately 8,000 square miles of territory.

The slope of the river below the dam for 100 miles has an average fall of nearly 4 ft. to the mile. Within a few miles of El Paso this changes to approximately 3 ft. and below El Paso the slope has decreased to approximately 2 ft. During August, 1921, discharge from local rains below the storage reservoir resulted in a flow of 4,000 sec.-ft. in the Rio Grande at El Paso, which flooded approximately 4,200 acres. Precipitation records have been kept at El Paso for 43 years, and at various other surrounding points for a shorter period. The greatest precipitation on record was for July 9, 1881, when 7.8 in. of rainfall was recorded in 24 hours at El Paso. The average annual rainfall for the area under consideration is 10 in. On Aug. 25, 1921, an ordinarily dry arroyo near Hatch, N. M., 80 miles above El Paso discharged 7,000 sec.-ft.

Investigations were made of the results to be obtained in lowering and straightening the river below El Paso by means of dredging, cutoffs, levees and an artificial waterway. The solution of the problem is rendered more difficult by the fact that the Rio Grande from El Paso south is an international stream and the approval of both governments must be obtained. The remedy proposed by the report is a general rectification throughout the section of the valley between El Paso and Fort Quitman, Tex., whereby it will be straightened, shortened and deepened. The resulting increase in rate of flow in the channel of the normal amount of water would be sufficient to carry through that section of the valley without disposition, the full load of sediment delivered from the upper valleys.

J. L. Campbell, president of the American Railway Engineering Association and chief engineer, El Paso & Southwestern R.R., acted as chairman of the flood control committee and rendered a report to W. E. Robertson, president of the El Paso Chapter, A.A.E.

Air Photos as Plane-Table Sheets Aid Mapping

Studies Made Along the Knoxville to Chattanooga Section of the Mississippi River—Contours Accurately Sketched in by Field Party—Method Supplies Wealth of Detail

By Harold C. Fiske
Major, Corps of Engineers, U. S. A., Chattanooga, Tenn.

I HAVE noted with interest the letters published in *Engineering News-Record* on the uses of aerial photography in map-making. Some of these are written by men who have had an intimate association with this class of work and others come from those who seem to have had less personal experience with map-making of this kind and to be prejudiced against this method, largely on theoretical grounds. The experiences of the U. S. Engineer Office at Chattanooga, Tenn., along this line may be of some value.

In 1921 a survey of the Tennessee River was ordered with a view to studying future developments in the interests of navigation and possible simultaneous development of water power. A contoured topographic map of all the terrain below an elevation of 60 ft. above the low-water mark of this river was considered necessary. Funds available limited the studies to that part of the river between Knoxville and Chattanooga. In this section there were already available the U. S. Geological Survey quadrangles on a scale of 1:125,000, with a contour interval of 100 ft., made 35 to 40 years ago. This scale was too small, the contour interval was too great and the sheets were otherwise too inaccurate for our purposes. There also existed an excellent map on a scale of 1 in. to 200 ft. of the river throughout this section, but this showed only the river between bank lines, the shoals, character of bottom, profile, etc., and was not reliable at elevations greater than 10 or 15 ft. above low water. It is, however, very accurate insofar as the stream proper is concerned. Many other maps of all or parts of this section exist, but none was sufficiently accurate and detailed for our use. It was then evident that a new map would have to be made, and after careful investigation it was decided to make use of aerial photography in this work.

An airplane with complete equipment and trained personnel was supplied by the Air Service, U. S. A., and about 1,000 photographs of the desired area were taken, developed and printed by that service by Oct. 1, 1921. The plane flew at an elevation of 12,500 ft. and the resulting photographs showed the terrain on a scale of 1 to 15,000. Each photograph is about 7 x 9 in. and covers an area of about 4 sq. miles. Successive views overlap by about 50 per cent and adjacent flights overlap by from 5 to 50 per cent. It has already been brought out by your correspondents that the maximum errors in displacement due to the principles of the lens are to be found along the edges of photographs, and it often happens, after a score or so of photographs have been formed into a mosaic, that more can be added only by the boldest kind of "fudging." In our work this could not be permitted. Moreover, of all the details shown in these views some are of vital importance to us, others are of comparatively little importance and still more of no value at all. It was accordingly decided that from these photographs a map should be prepared on which due prominence would be given to important items while those of less or no importance would be minimized or omitted altogether. The following line of procedure was adopted and has now been in operation for some months.

A survey party was sent into the field with two plane-tables, the necessary accessories, personnel, etc. The photographs were sent to this party and used as plane-table sheets with instructions to so choose among the available views that, as far as possible, the field work would appear in the center of the photograph. Unfortunately, due to the manner of taking these pictures, we have been unable to follow this principle as closely as we would like, but in future flights we believe that there will be no trouble in taking care of this point. With the photographs as a plane-table sheet in the field the surveyor, by the usual stadia methods, locates and determines the elevation of the points necessary for contours and the contours are then drawn on the photograph. All other details, roads, railroads, fields, streams, houses, etc., are already shown on the photograph, and when contouring is completed at one station the surveyor moves on to the next.

While the field work is going on the office draftsman, working on a duplicate set of prints, locates on the photograph, successively, two or more points along the river which are common to two adjacent photographs and easily distinguished. These photographs may be successive ones from the same flight or they may be adjacent ones taken in different flights. The river bank line is traced from the first view on ordinary tracing cloth, then the selected points on the next photograph are brought into position under the same points as taken from the first view. This orients the second view and the bank lines are continued on the tracing, the process being repeated with the third view and so on.

The latest developments in our work permit these points to be away from the river as well as on it, thus increasing the number of checks on the work and the rigidity of the control. In this operation certain differences are noted at times in the scale of adjacent photographs but such discrepancies may readily be eliminated or neutralized. It does not seem worth while to attempt to describe these processes in detail here. Suffice it to say that we have a very accurate check in our 1 in. to 200 ft. ground traverse map. In one of the first plane-table-photograph sheets the bank lines, as given by the ground survey, were finally used for a short distance instead of those obtained from the photographs because of the irreconcilable differences found in the views concerned. Since then our technique in this operation has improved materially and we have not had to use the ground survey for several months. In fact there are places where we are satisfied that our 1 to 15,000 plane-table-photograph map is more accurate than the 1 to 2,400 ground traverse map.

Besides the bank lines of the Tennessee those of large tributaries are traced at this time as well as railroads and the main highways. This office operation furnishes

a complete and rigid skeleton to which the field photographs with their contours, houses, fence lines and other details are added by tracing as they come in from the field. Some office adjustments have had to be made occasionally to secure a perfect fit of these field photographs, but the number of such adjustments has steadily diminished as the technique of the field and

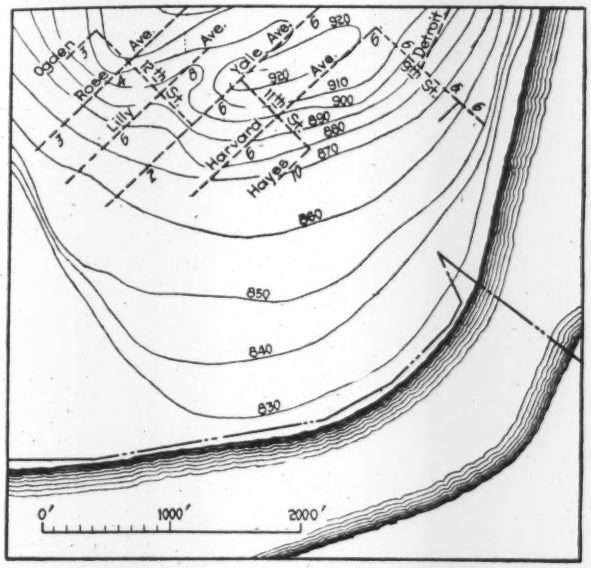


FIG. 1—AREA MAPPED FROM GROUND SURVEY

office force has improved. I should say that this number of office adjustments has never been equal to that commonly experienced in the plotting of the field notes of the standard transit-stadia survey.

P. J. Barry (see *Engineering News-Record*, May 4, p. 746) apparently wants to see a comparison between a map from a first-class ground survey and one of the same area from aerial photographs. Our present survey is being made because no such maps exist for the area we are covering, except the bank line surveys above referred to, which are incomplete for our purpose. At one point, however, we overlap for about 200 acres a contour map from a ground survey made by a well known engineering company of unassailable reputation. The area covered in this section is too small to carry great weight as proof of the superiority of either method over the other, and from the engineering company's point of view, probably, these 200 acres were not of much importance and consequently were perhaps more hastily done than usual.

Fig. 1 is this area mapped by a standard ground survey, and Fig. 2 is the same area as determined by our plane-table-photographic method. Comparing contours, those on Fig. 1 are the standard generalized contours with which engineers have long been familiar, while those on Fig. 2 have an individuality which, to my mind, is in itself proof of their superiority. A comparison of these two maps with the ground will show Fig. 2 to be the more accurate. From Fig. 1 it will be noted that the engineering company omitted the railroad, the railroad bridge and the railroad yards and probably guessed at the width of the river, probably because these items did not enter into any of the problems with which they were concerned. In Fig. 2 the river was of course essential, but the railroad, bridge, etc., were added because of their general interest and potential value, and because these were already shown on the photographs as accurately as they could possibly have been sketched to this scale in the field. The only added time or expense involved was that required of the office draftsman to trace them neatly, only a few minutes work and no appreciable added expense.

Finally, contours can be traced more quickly and accurately on the aerial photograph than on the customary plane-table sheet. In the latter case the topographer has nothing to guide him but the dots with their elevations which he has located on this otherwise empty sheet and the appearance of the terrain as he looks at it, more or less foreshortened, from his station on the ground. I doubt if this foreshortening has ever been given enough serious consideration, for we are constantly running into evidence in the aerial photograph that the ground topographer on other maps made too great or too little allowance for this source of error. The topographer with the aerial photograph has the points which he has established on the photographs and can also observe the terrain as freely as can any other ground surveyor. In addition, his photograph shows him a wealth of easily identifiable detail such as roads, fences, brooks, dry runs, trees, bushes, bare spots on the ground, etc., which are important guides in locating definitely the position of his contours. The result is that on the aerial photograph he can sketch them in with greater certainty and greater rapidity than he can on the standard plane-table sheet. This is not a theory; it is the report of the field topographers after months of experience with the aerial photographs.

As an over-all check the 1 to 2,400 traverse bank line survey was reduced to a scale of 1 to 15,000 and a

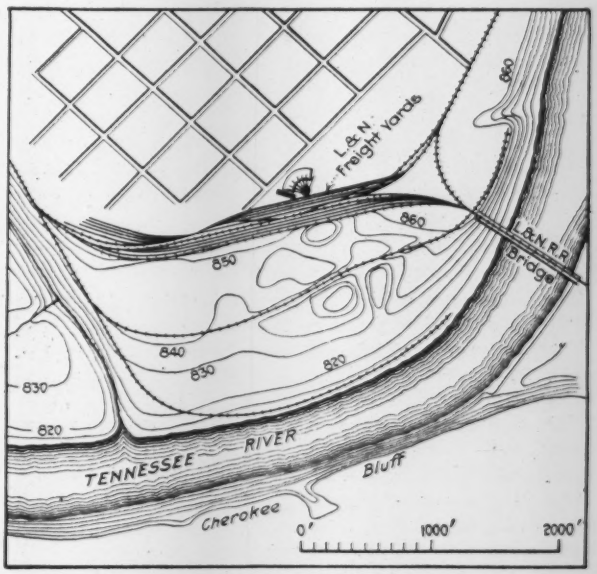


FIG. 2—SAME AREA AS SHOWN IN FIG. 1 DETERMINED BY PLANE-TABLE-PHOTOGRAPHIC METHOD

16-mile section of the river mapped by this method was compared with the same section mapped by our present method where no horizontal control was used other than that obtained from the aerial photographs. The check showed absolute agreement in over-all dimen-

sion as close as these dimensions can be scaled from these sheets. This section of our present map covers about 33 sq. miles. Streams, roads, railroads, fence lines, houses, etc., are shown in practically complete detail throughout this area, also contours up to about 60 ft. above extreme low water. In this way contours are given for about 20 per cent of the area covered by this section. [A print of the map referred to was submitted by Major Fiske with his article and bears out the claims made for it. As it could not have been reduced to a width of only 7 in. to be shown on a page of this size without losing practically all detail a cut of the map has been omitted.—EDITOR.]

The total cost of this sheet covering 33 sq. miles was about $1,500. The field work occupied 38 calendar days, or 32 working days. The preparation of the skeleton control took one man 60 hours; the tracing of detail from the field photographs took one man 24 days. The field work was done by a party of 12 men, including two plane table parties, cook, launch runner, etc., who lived on a quarter boat on the Tennessee River.

The purpose of our present mapping operations is to produce a map which will give all data needed for a thorough study and definite conclusions relative to future developments physically possible along the Tennessee River for navigation or for water power or for a combination of both. Should this work proceed to a point requiring full detailed information relative to dam sites or exact areas involved in damage claims, etc., we suppose that more work will have to be done on the ground. We do not yet know what is the limit to which our present method may be carried with profit, where minute detail is essential. We can undoubtedly go further in this direction than we have so far attempted, but this is a distinctly different problem and forms a bridge which we will try to cross only when we come to it.

So far I believe that our work meets every demand that can properly be made of maps of this scale; that as far as instrumental errors are concerned it is for all practical purposes as usable as that done by ground survey methods alone; and that where errors due to the human equation are concerned our plane-table-photograph maps are distinctly superior to ground-survey maps.

Early Morning Evaporation Greatest

The establishment of the fundamental basis of the law of evaporation from a free water surface is the ultimate aim of an elaborate set of experiments undertaken at Fort Collins, Colo. These experiments are being conducted in still air at the hydraulic laboratory under co-operative agreement between the Colorado Experiment Station and the Irrigation Division of the Bureau of Public Roads, U. S. Department of Agriculture By means of delicate instruments it has been possible to follow the variations in evaporation occurring from small changes in temperature and humidity. Evaporation losses at 5-min. intervals are measurable. One of the unexpected features which this close following at short intervals permits, is that under still air conditions maximum losses occur during the early morning hours, a phenomenon contrary to what is generally expected to occur. Since this work is not yet completed, details of the results of the experiments are not yet available.

Dr. William Dunbar; *An Appreciation*

BY GEORGE W. FULLER
Consulting Engineer, New York City

THE untimely death a few months ago of Prof. Dr. William Dunbar, Director of the Hamburg State Hygienic Institute, Germany, removed one of the ablest investigators in the field of biochemistry as applied to sanitary engineering. His book, published some fifteen years ago, on "Principles of Sewage Treatment," remains one of the principal books of reference for those who have occasion to inquire closely into the development of the art and science of sewage treatment.

Dr. Dunbar was an American, the son of a banker of St. Paul, Minn. With his family he lived as a youngster in Germany, where he studied medicine and received his degree about thirty years ago at the University of Giessen. He was attached there in the bacteriological laboratory to the staff of the professor of hygiene, Dr. Gaffky. The latter was a member of the Imperial Board of Health of Germany and when the severe epidemic of cholera broke out in Hamburg, in 1892, he took young Dunbar with him to carry on laboratory searches for pathogenic bacteria in the River Elbe and to study methods of disinfection. Dunbar became an important factor in making these and numerous other investigations at Hamburg and for nearly thirty years was the diligent, painstaking and resourceful director of one of the foremost laboratories in the field of public hygiene.

To many engineers the writings of Dunbar were inspiring. Besides the book already mentioned, his various contributions in the *Gesundheit-Ingenieure* were carefully read in this country and abroad. While not attached directly to any large engineering undertakings he was a technical advisor on a number of important sewage-works in Germany. Particular mention should be made of his searches at Hamburg on the deep-well water supply and of means of freeing it of excess iron.

The official position of Dr. Dunbar and his numerous visits to England brought to him an unusually accurate knowledge of the history of legislation designed to remedy the pollution of streams. On some of the large British sewage disposal undertakings he was a witness before parliamentary committees and he was one of the principal experts retained by Dr. John G. Watson, chief engineer of the Birmingham Sewerage District, in connection with litigation associated with the local works.

In the field of preventive medicine his contributions were numerous and important, particularly with respect to bubonic plague and hay fever.

Dr. Dunbar will be missed by a large number of Americans, particularly sanitary engineers, who far many years during their visits abroad found him a most helpful guide in getting acquainted with activities in the field of sanitation in Europe. Professor Dunbar was well acquainted with developments in America, although his visits here were infrequent, the later ones having been in 1904 and 1908.

Many American engineers will always remember with deep appreciation the many kindnesses extended to them by Dr. Dunbar and will regret his untimely death.

[Dr. Dunbar's "Principles of Sewage Treatment," as translated from the German by H. T. Calvert, was reviewed in *Engineering News*, April 15, 1909, pp. 41-3 of the Engineering Literature Section.—EDITOR.]

Wharfhouse at New Orleans Army Base Destroyed by Fire

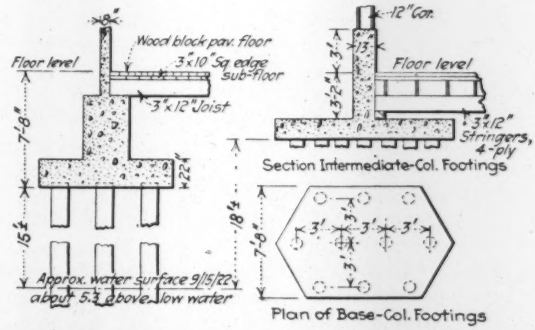
Steel Frame Warehouse and Pile and Timber Quay Total Loss — Concrete Warehouses Not Harmed — Insufficient Fire Protection and Inaccessibility to Fire Apparatus Blamed

By Arthur M. Shaw
Consulting Engineer, New Orleans, La.

On the night of Sept. 15, 1922, fire destroyed the wharf and wharfhouse which were built by the government during the war, as an adjunct to the Army Supply Depot at New Orleans. The site of these facilities is at Poland St., along and adjacent to the river front, about two and a half miles below the business center of the city. The wharf, or rather quay, was 2,000 ft. in length by 170 ft. wide. The wharfhouse was of the same length by 140 ft. wide, with platforms on either side for handling freight, one of 10 ft. in width on the land (and track) side and one of 20 ft. on the river side. The building was of two stories, the first story being 20 ft. and the second, 17 ft. high. The entire development was described in *Engineering News-Record*, Apr. 24, 1919, p. 823.

As the wharf was constructed entirely on the river side of the levee, it was necessary to carry it on pile supports. The three "Belt Line" tracks at the rear were also constructed on pile trestles. The crown of the river levee was approximately 75 ft. to the rear of these tracks.

The framework of the wharfhouse was of steel columns and beams, the columns being supported by reinforced-concrete footings as indicated in the drawings. The columns were spaced on 20 ft. centers in each direction. Cross fire walls were constructed at 200 ft. intervals. These were also of reinforced concrete and rested on pile supports as shown by the drawings. The walls ended in a "T" head at each end, these heads being 15 ft. in width and forming a section of the outer wall, flush with the galvanized iron covering. It is probable that the height of cutoff of pile supports of fire walls was controlled by the stage of the river at the time that this work was done, and that their bottoms were above the river stage at the time of the fire.

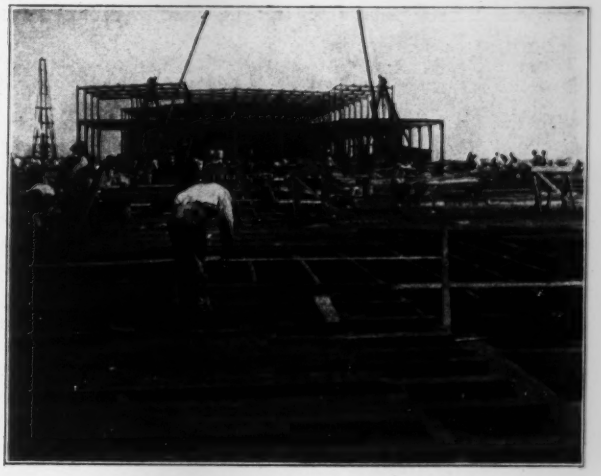


DETAILS OF FOOTING AND FIRE WALL CONSTRUCTION

Left section taken right angles to river. Steel columns rest in wall; base of columns 3 ft. above floor level. At columns wall increased to 21 in. thick to encase columns spaced 20 ft. c. to c. each way. Intermediate columns not in fire wall not encased or protected—Right; details of base of fire wall and concrete column footings.

Floors were of creosoted wood blocks with sand cushion on a sub-floor of 3 in. square-edge rough planks. The type of floor construction is shown in the drawings and in one of the views. All piles and timbers were creosoted.

Both stories of the building were equipped with automatic sprinkler systems, supplied by a 12-in. main running under the lower floor and fed at three points by two 12-in. and one 10-in. connections. These lines were supported by means of ¾-in. round steel stirrups which were hung from floor timbers by lag screws



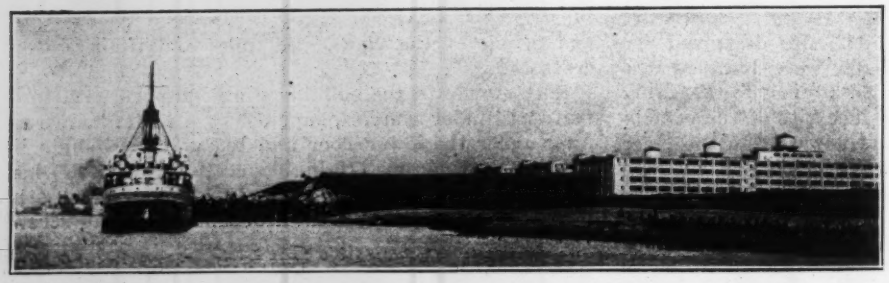
NEW ORLEANS WHARFHOUSE UNDER CONSTRUCTION

threaded through the single eye which was bent into each end of the stirrup rod.

Course of Fire—The fire was discovered at about 8:15 p.m. in a car of burlap which was on the track nearest to the wharf and about 500 ft. below the upstream end of the building. Government and dock employes attempted to put out the fire (after sounding an alarm) by the use of emergency fire hose provided for the purpose but were soon driven back by the intensity of the heat. This hose was in use only a short time, perhaps fifteen or twenty minutes, when the water pressure dropped, rendering the hose ineffective. At the time of the fire, a heavy offshore wind was blowing and a number of witnesses mentioned the fact that the blaze from the burning cars of burlap appeared to be drawn under the floor of the wharf (which was at car floor level) as through a chimney. Investigations have been conducted by various official bodies but while no decisions have been made public, the fact appears to have been established that the fire originated in the car of burlap first discovered and was then driven by the strong wind to the substructure of the wharf. An examination of water main hangers at points where the timbers to which they were attached were only slightly scorched or charred, showed that the ⅝ x 3-in. lag screws lost their grip soon after they became heated, permitting the dropping and rupture of the mains. This doubtless accounts for the sudden drop in water pressure already noted, as well as the failure

of sprinkler systems to operate during the later stages of the fire.

Two vessels were tied to the wharf at the time that the fire broke out, one of these being without steam. This vessel suffered considerable damage before it was towed out into the stream. A panic arose among the crew, seven members jumping into the river, apparently with the idea that the vessel was doomed. Three were drowned, these being the only fatalities in connection with the fire.

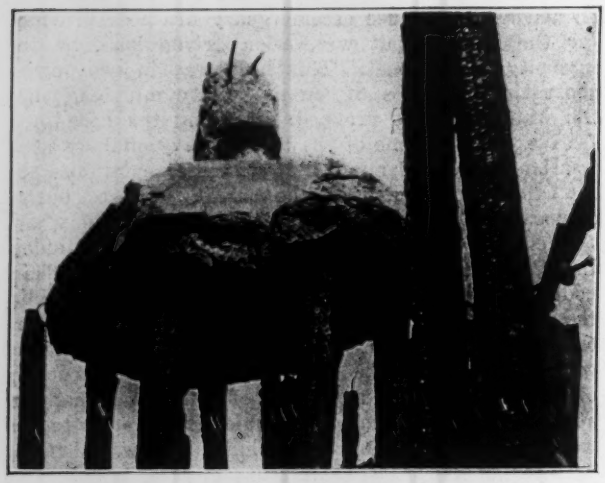


LOOKING TOWARD NEW ORLEANS ARMY BASE AFTER THE FIRE OF SEPT. 15, 1922
Detroyed wharf and wharfhouse at left behind ship, then connecting bridges and at right the concrete warehouses which were not harmed by the fire.

Practically the entire fire fighting equipment and organization of the city was called out and was engaged in fighting the fire from the land side while the Dock Board fire tug, supplemented by a number of privately owned tugs, pumped water on the fire from the river side. It was practically impossible to reach the timber substructure with streams from either side, the burning of which was assisted by the strong cross draft already mentioned.

The entire wharf and building were destroyed, resulting in a loss of the government owned wharf and house, together with a small amount of stores awaiting shipment, of about $3,600,000 and commercial property on the wharf and in cars estimated at from one to three millions. Twenty-eight cars were also destroyed. The burned commodities consisted principally of burlap, cotton bagging and news print paper. The wharf had been leased by the government to the Board of Port Commissioners for use as a commercial port facility.

Spreading of the fire to other structures was prevented with the exception that in a number of instances small fires were started across the river in Algiers by balls of burning burlap which were carried there by the heavy wind. These were extinguished without damage to property. The nearest exposure was the state owned Desire St. wharf which is used by the Cuyamel Fruit Co. as a banana wharf. This was separated from the burned structure by an open basin 180 ft. in width. The main Army Supply Depot buildings of concrete were 320 ft. to the rear of the wharf with no connection other than three all metal conveyor bridges. These bridges were wrecked at the wharf end when the building collapsed. There were no exposures at the downstream end of the wharf as this adjoined the reservation of the Inner Harbor Canal which is to be cut in to the river at this point within the next few months.



CONCRETE COLUMN FOOTING AFTER THE FIRE
Six of the original ten piles still support the footing. Note foundation bolts projecting.

Conditions After Fire—An examination of the burned area, from both land and river sides shows:

None of the fire walls remains standing above the level of column bases with the exception of a few of the "T" heads described.

Some of the fire wall bases have dropped from failure of pile supports. It is not certain whether this occurred before or after the failure of the upper portions as noted below.

The lower portions of some of the fire walls are still intact, it being apparent that the upper portion was pulled over by the falling of the steel superstructure of which the columns encased in the walls formed a part.

Similar conditions were noted with regard to the intermediate column supports, many of these still being supported by charred piles and carrying the steel columns which have bent over at a sharp angle just above the foundation bolts.

While both the fire walls and the concrete column footings show evidence of severe spalling (some of the reinforcing rods being exposed) it was not apparent that failure of any of the concrete was due to this cause.

Some fusing of steel members was noted though this was not general, the most of the members being of original section but badly bent and twisted.

The creosoted timbers and piling, which had weathered for nearly four years since treatment, appeared to have offered considerable resistance to ignition and to burning after ignition, excepting where exposed directly to strong draft. Practically all thin members, such as sway braces, were fully burned. Many instances were noted of timbers which were subjected to extreme heat (but not to direct and continuous draft) which were scorched and charred but the section and strength of which were not seriously impaired.

Failure to Control Fire—The apparent causes of the failure to control the fire are as follows:

No automatic sprinkler system for the most inflammable portions of the structure, the timber and pile substructure.

Design of timber substructure favorable for rapid ignition.

Access to a fire in the substructure made difficulty by the levee, railway trestles and strings of cars.

Insufficient floating fire fighting equipment.

Ineffectiveness of cross fire walls due to their not extending down to low water and to their apparent early failure structurally.

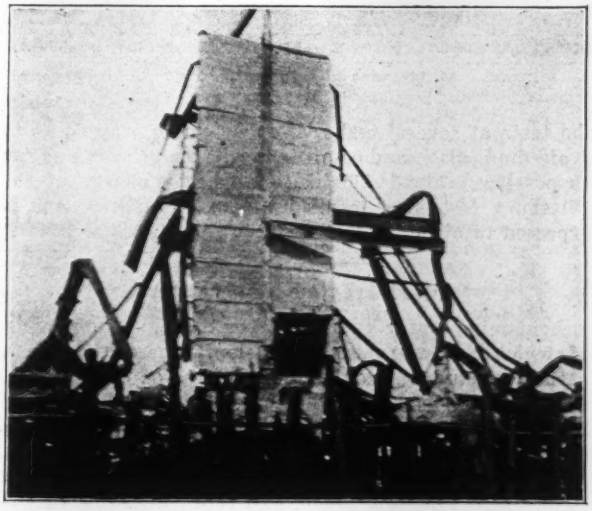
Reduction in available water pressure from dropping and bursting of mains which were carried by hangers of improper design, from wooden floor timbers.

Delay of many of the fire engines in reaching the fire. This was due principally to an insufficient number of well paved streets. There is only one street, leading from the business center of the city to the lower section, which is suitable for ordinary fast traffic. This street (Burgundy) is only 30 ft. wide between curb lines while at intersections, this is narrowed to about 26 ft. by gutters covered by iron plates. It soon became congested by fire apparatus, ambulances and automobiles carrying sightseers.

It is possible that "harbor oil" was also a contributing factor as difficulty has been experienced in this harbor, as well as in most others, in enforcing regulations relative to throwing waste oil out of vessels as they lie in port. Rings of heavy oil, frequently with imbedded rice hulls, were observed on piles in the immediate vicinity of the fire.

It is probable that the most important factor in the rapid spread of the fire was the strong and unobstructed draft under the structure which carried the fire to points which could not be reached effectively by ordinary equipment.

Lessons from Fire—While substantial loss might have resulted, even if all practicable precautions had been taken, it would appear that the fire could have been held within reasonable limits if the following had been provided:



HEAD OF A CROSS FIRE-WALL AFTER THE FIRE

A system of water mains placed so as to be as nearly as practicable, independent of inflammable or weak portions of the structure.

Fire walls carried down to low water and of such design that they would stand even after destruction of framework.

One or more longitudinal curtain walls, extending down to low water, to cut off cross draft.

Prompt service of switch engines to move exposed cars.

Suitable regulations to provide frequent openings in strings of standing cars, to permit easy access to the wharf.

More fire plugs adjacent to such structures, to permit the prompt service of a large number of engines.

Drastic control of the "harbor oil" menace.

Better design of timber substructure. Timber wharf construction, at least in this section, appears to have evolved from the railroad pile trestle. It is suggested that a design be developed more nearly along the lines of "slow burning mill construction," eliminating the thin members commonly employed for sway and sash bracing and giving special attention to design of joint details.

FLOATING OIL JUST THROWN OVERBOARD FROM BOAT

There is a possibility that this oil exaggerated the fire menace at the New Orleans terminal.

In addition to the foregoing, is the obvious necessity for more well paved streets and better police control of unnecessary traffic in the vicinity of the fire which might interfere with prompt and rapid movement of fire apparatus.

High Pressures in Riveting Injurious

Tests of the effect of riveting made by Prof. R. Baumann, briefly abstracted in *Zeitschrift des Vereines deutscher Ingenieure* of May 20, indicate that both the thermal stresses and the stresses caused by high riveting pressures have a tendency to open up cracks in the plates connected. To obtain an estimate of the thermal stresses, comparative tests were made with hot-driven iron rivets and with cold-driven lead rivets, which showed that the temperature stresses exceed the others. Among the conclusions from the tests are the following: A high riveting pressure is likely to produce stresses in the plate exceeding the yield point; the plate reaches temperatures exceeding 500 deg. C. during riveting, and large temperature stresses result from this heating; the most unfavorable stress conditions occur at the faying surfaces, between plates in contact, directly adjacent to the rivet hole; the stresses are largest in the case of rivets close to the edge of the plate; pressures of 90,000 to 115,000 lb. per square inch of rivet shaft are sufficient for producing tight rivets and minimize the distortional stresses caused by the pressure.

Concrete Road Tests Completed at Pittsburg, Cal.

New Road to Be Built Consisting of Ten 90-Ft. Sections of Different Types Including Asphaltic and Cement Concrete

TESTS of concrete pavement that have been under way during the past year at Pittsburg, Cal., latterly under the joint supervision of the U. S. Bureau of Public Roads and the California State Highway Commission, have been completed, so far as the scope and extent of the tests originally planned is concerned. Reports on the purpose and progress of these tests appeared in *Engineering News-Record*, Dec. 29, 1921, p. 1049 and June 29, 1922, p. 1066. Supplementing the data previously published, final figures for total traffic over the Pittsburg pavement from Nov. 9, 1921, when the tests started, to Aug. 21, 1922, the last day of traffic tests, are as follows:

Weight in Pounds			Mileage			Number of Truck Trips			Tonnage		
			Position on Pavement			Position on Pavement			Position on Pavement		
Front Wheels	Rear Wheels	Total	Inner Side,	Outer Side	Center	Inner Side	Outer Side	Center	Inner Side	Outer Side	Center
2,330	6,970	9,300	.....	.....	.....	.....	121	.....	.....	560	.....
5,250	9,250	14,500	12,987	.....	.....	51,450	.....	.....	373,080	.....	.....
5,300	9,350	14,650	.....	13,292	.....	.....	49,588	.....	.....	363,290	.....
4,100	12,300	16,400	.....	5	.....	.....	21	.....	.....	170	.....
4,150	12,450	16,600	7,800	.....	.....	31,016	.....	.....	257,420	.....	.....
4,200	12,500	16,700	.....	13,357	.....	.....	49,555	.....	.....	414,510	.....
5,500	16,500	22,000	10,936	5,332	.....	43,492	19,780	.....	478,110	217,660	.....
6,950	16,700	23,650	39,339	.....	.....	157,586	.....	.....	1,862,470	.....	.....
7,000	16,800	23,800	.....	41,019	.....	.....	153,449	.....	.....	1,825,800	.....
6,150	18,350	24,500	3,308	3,467	18,080	13,151	12,878	69,611	161,180	157,860	853,160
6,750	20,250	27,000	390	448	.....	1,546	1,666	.....	20,880	22,470	.....
6,850	20,400	27,250	.....	.....	6,470	.....	.....	24,906	.....	.....	339,640
7,500	22,500	30,000	.....	13	1	.....	50	.....	.....	750	.....
7,600	22,650	30,250	.....	.....	127	.....	.....	491	.....	.....	7,430
10,000	21,400	31,400	.....	2	.....	.....	8	.....	.....	120	.....
	*32,050	32,050	.....	28	.....	.....	105	.....	.....	1,680	.....
13,700	25,200	38,900	.....	2	.....	.....	7	.....	.....	140	.....
9,300	30,400	39,700	.....	32	.....	.....	123	.....	.....	2,440	.....
16,150	32,300	48,450	.....	2	.....	.....	6	.....	.....	140	.....
	*61,710	61,710	.....	2	.....	.....	9	.....	.....	280	.....
22,000	44,450	66,450	.....	2	.....	.....	8	.....	.....	270	.....
.....	*70,000	70,000	.....	1	.....	.....	3	.....	.....	110	.....
.....	*80,000	80,000	.....	1	.....	.....	2	.....	.....	80	.....
.....	*100,000	100,000	.....	1	.....	.....	3	.....	.....	150	.....
.....	.....	.....	.....	135	.....	.....	518	.....	.....	3,250	.....
Also additional loads incidental to special tests.			74,760	77,141	24,677	298,241	287,900	95,008	3,153,140	3,011,730	1,200,230
			Total ..... 176,578 miles			Total ..... 681,149 trips			Total ..... 7,365,100 tons		

* Two-wheel trailer.

With the conclusion of the first tests comes definite announcement of a new series of tests to be begun at the same site as soon as new pavements can be laid. The new series will have the advantage of experience gained in the work just completed and will comprise a scope and degree of refinement not possible in the earlier series. There will be ten 90-ft. sections of different construction on tangents and transverse tunnels are to be put under each of these. There will also be at least two longitudinal tunnels on the edges of the slabs, a tunnel under joints, and a "room," or combination of longitudinal and transverse tunnels for special tests.

The length of the new test road on tangents will be the same as on the first road. The four 118-ft. sections on the curved ends of the old road were not broken down and it is proposed to use these in the new tests, supplementing them by the addition of old macadam pavement of equal width outside the old curves. Oil macadam of the eastern type will be used on one end and of the western type on the other. This will provide alternate routes on curves so that repairs to either may be made without interrupting traffic and also so that comparative maintenance costs may be observed. It is also proposed to lay two sections of asphaltic concrete pavement on the tangents for a direct comparison with portland cement concrete.

In the light of Wyoming experiments with concrete pavement in precast sections, it is proposed to lay one or more of the 90-ft. sections on the new test road with construction of this type.

In view of the special conditions of practically impervious subgrade secured by the methods of compacting the fill under the first road, it has been suggested that that subgrade be removed and replaced with material deposited as in ordinary highway fills. Management of the new series of tests is expected to be in the hands of the U. S. Bureau of Public Roads and the California State Highway Commission, the same as heretofore.

A. T. Goldbeck, chief, division of tests, Bureau of Public Roads, and chairman of the committee on structural design of roads of the National Highway Research Council, has called a meeting of that committee at Washington, D. C. early in October, at which time it is planned to work out some joint program carrying on the tests at several test roads now under way so as to avoid duplication and co-ordinate the experiments as far as possible. Lloyd Aldrich, engineer in charge of the Pittsburg test, is a member of this committee and is expected to attend the Washington meeting.

Marl Treated Mine Water

Acid mine water containing 17,800 p.p.m. of solids, of which 840 were in suspension, passed through a natural calcium clay or marl at a mine of the Triangle Clay Co., Ulrichsville, Ohio, had in the effluent only 2,520 p.p.m. of solids, of which 60 were in suspension. The solids in the water were largely sulphates of iron, calcium and magnesium, the iron sulphate giving a strong acid reaction which, expressed in terms of sulphuric acid, amounted to 446 p.p.m. Although the other solids in the treated water similarly expressed in terms of acid amounted to 87 p.p.m. they were largely non-acid-forming calcium and magnesium sulphates. The passage of the water was through several layers of the marl in a baffled tank, the last compartment of which was filled with cinders to filter out the suspended matter and results of the chemical precipitation. The system was developed by the stream pollution department of the Ohio Fish and Game Division.—*Coal Age*, Aug. 10, p. 201.

Engineering Construction Work Under Foreign Laws

U. S. Bureau of Foreign and Domestic Commerce Would Help Guard American Contractors Against Pitfalls Abroad

By A. J. Wolfe
Chief, Division of Commercial Laws

Abstract of article in U. S. Commerce Reports

STATISTICS of exports from the United States to foreign countries fail to reveal the full indebtedness of American trade to American engineers and contractors. In Mexico and in South Africa, in Siam and in the Altai region, in Australia and in Peru, in Brazil and in China, the American mining engineer, railway builder, dredging contractor, the builder of bridges have left an indelible impress, but American engineering achievement in foreign countries is hidden to the eye that in statistics sees mere data. It is there neverthless.

In the early days the American engineer went abroad in the fashion of the pioneer. He had training, the American genius for solving problems, and the knack of overcoming obstacles both natural and artificial with the minimum of friction, physical or social. A landslide or a rising, a flood or a bold local chicane—it was all in a day's work. The engineer had to meet situations as they arose; consequently he amassed invaluable experience in coping with all sorts of emergencies abroad, an experience that it is difficult to put in the form of written statements. When the Division of Commercial Laws was organized in the Department of Commerce, and was assigned the task of compiling and disseminating data on the operation of laws abroad affecting the conduct of business by American firms, it planned an investigation into those legal problems which confront the American contractor or engineer who repairs to a foreign country for a limited time to execute an engineering contract, which may be with a government, with a state or municipal authority or with private interests. Or, a force of engineers may be sent to a foreign country where their chief must hire his laborers or other employees directly or through a local labor contractor.

The Engineer's Problems Abroad—Immediately the erecting engineer comes in contact with foreign laws. His position is very different from that of a resident manager of the branch of a commercial house. He is not in the country to stay. The thought of incorporating under the foreign sovereignty would not occur to him because of his temporary stay. Yet in many ways his contact with local laws is more direct and more pregnant with possibilities of trouble. He is frequently the paymaster, he incurs liability under labor indemnity laws, and in many undeveloped districts the opportunity of holding up a supposedly wealthy American corporation may be a serious temptation to irresponsible politicians. An American engineering corporation suggested to the Division of Commercial Laws a worldwide inquiry into the legal requirements concerning American engineers and contractors in foreign countries. As a result a questionnaire was sent to the field men of the Department of Commerce and through the courtesy of the State Department to American consular offices in a selected list of foreign countries. This step was discussed both with engineering corporations and with economists, and while the former were enthusiastic, some of the latter felt that the inquiry would elicit little that would be worth while. One economist specializing in the affairs in Near Eastern Europe expressed his opinion that in that particular territory there was little of interest to American contractors; but the same day there appeared in the paper a news dispatch announcing the conclusion by an American corporation of a gigantic engineering contract in that part of the world, so he was reluctantly converted.

The Commerce Department Questionnaire—The text of the questionnaire finally sent was as follows:

"Contractor's Requirements Abroad

"1. Is it advisable for engineering corporations undertaking temporary contracts in your territory for official or private interests to obtain domestication or to register their company?

"2. How is this effected?

"3. Will it suffice for the engineer in charge, an American citizen, with power of attorney for the company, to register as an individual?

"4. What taxes must the company pay? (In answering this question bear in mind that the company undertakes the work at a fixed price payable in part before the work is started and the balance after the work is finished. Profits can not be determined until the work is completed.)

"5. Describe the liability for injury to laborers under the laws of your territory. Can insurance be obtained for this liability? Can contractors' insurance be secured?

"6. Kindly send any additional information available now or in the future which might be of importance to American contractors undertaking work in your territory.

"7. Can you give names of American companies which have undertaken such work in your territory, so that we may write them direct for the benefit of their experience?"

The questionnaire was submitted to several American companies with experience in foreign engineering contracts, and they expressed intense interest in the investigation. One of these companies submitted the following valuable list of suggestions:

1. (a) An employee of a corporation sent to a foreign country, if there as the sole representative of that corporation, should carry with him a properly executed power of attorney, which power of attorney should be executed to only cover specifically the things said representative is to do. If he goes with general duties, then his power of attorney should be very broad and very general. Aside from specifically naming everything that the representative can do a blanket clause may permit him to do "All and everything necessary even though not specifically mentioned herein." (b) Unless the particular country requires the registration of a representative it would not be necessary to make registration. (c) If no registration is required in the particular country, he should register his name and address, also company represented with the United States Ambassador, Minister or Consul.

2. It is our understanding that (in South America) a citizen of the United States while operating there is amenable to the employers' liability laws, labor laws, etc., if he engages in the execution of construction work of any character or employs anyone in that country to work for him. He may also be liable as a co-employer.

3. A representative should familiarize himself with the commercial laws of the particular country he is operating in and can usually be advised by the official representative of the government in that particular country. Aside from the personal conduct of the representative, above all he should make no promises or commitments which are not to be carried out to the letter. Our general experience has been especially in South America, that it is an easy matter to transact business in the various countries there provided the representative confines himself to statement of facts at all times and the strict carrying out of all obligations or commitments made. Whether or not laws can be mutually agreed upon by your department and corresponding departments in the various foreign countries would of course be of great value and we would be pleased to have you advise us when this has been accomplished.

As the result of this questionnaire sent out about the end of April replies are beginning to come in, notably one from Commercial Attaché Chester Lloyd Jones, Havana, on contractors' requirements in Cuba, and another from American Consul General Claude I. Dawson, of Mexico City, on contractors' requirements in Mexico. These reports together with others still awaited, will be prepared for publication jointly by the Industrial Machinery Division and the Division of Commercial Laws. Contractors and engineers interested in this investigation are invited to communicate with the Bureau of Foreign and Domestic Commerce.

Extensive Boiler-Water Treating on C., M. & St. P. Ry.

Chemical Treatment in Bad-Water District Improves Operating Conditions — Savings Soon Pay for Numerous Plants

By C. Herschel Koyl
Engineer of Water Service, Chicago.

THE first duty of the engineer of water service on a steam railroad is to provide enough water at convenient points, with reliable pumping facilities and adequate storage. His second duty concerns the quality of the water.

In the systematic improvement of water service on a bad-water district of the Chicago, Milwaukee & St. Paul Ry., fourteen water treating plants have shown that they will pay for themselves in one year. Special features of the plants as developed for this service by the writer are: (1) Separate and independent feeds for lime, soda-ash and iron sulphate; (2) solution and feed of soda-ash by water spray; (3) upward flow in the mixing tank to insure agglomeration of the finer particles which cause boiler foaming, and (4) disposal of the sludge from the flat-bottomed settling tank by a system of underdrains.

In the country between Lake Michigan and the Rocky Mountains, part of the "great plains" of pioneer days, the Chicago, Milwaukee & St. Paul Ry. has more than 8,000 miles of steam-operated main track. Because most of this is a country of less than average rainfall, with few streams and fewer lakes, the railroad has many water problems to be solved in providing an adequate supply of water suitable for boiler purposes. These problems are most difficult in South Dakota, on the east side of the Missouri River, where the few streams run slowly through lands so rich in the soluble salts of calcium and magnesium that the river waters are always hard. The more rainfall there is on the adjoining lands and the higher the rivers rise, the harder is the water.

In that part of the country, because of the scarcity of water at or near the surface, most railroad supplies are derived from drilled wells. These wells vary in depth from 50 to 1,500 ft. and the character of the water varies as widely. There are two layers of sandstone whose horizontal cracks furnish the supply. The water from the lower sandstone is very hard, with 80 to 90 grains per gallon, and it carries also 20 to 60 grains of sodium sulphate or chloride. The softer water from the upper sandstone so closely resembles the lower water after softening that it is presumed to be the same water softened in the ground by zeolitic action.

At distances from 100 to 200 miles east of the Missouri, the soft water rises to ground level and is used by the railroad. But near the river the water appears to drain away somewhere because it must be pumped from a depth of 300 ft. Since this soft water is both scarce and difficult to pump, we drill to the lower sandstone and then soften the hard water thus obtained. This water usually rises to ground level. In this vicinity last year we drilled seven sand-proof wells.

Our experience with these waters for locomotive boilers had been so expensive, in spite of all the boiler compound that could be used, that last year we built fourteen water-treating plants on the lines running east, west and south from Mitchell, South Dakota, placing a plant at each water station for the sake of uniformity of water. This was in addition to three plants previously installed. The map, Fig. 1, shows the treated-water district of about 400 miles.

The new plants are continuous in operation. Each consists of the following main parts: (1) a hard water pump; (2) a 40-minute reaction tank within which the mixture of hard water and the necessary chemicals (all fed in continuous streams) is slowly stirred by mechanical means; (3) a 3-hour settling tank; (4) a treated-water pump which delivers to the track tank; and (5) a chemical storage room. All the apparatus is inclosed in a strong and well heated building. The main line plants are all alike. Each is capable of treating 15,000 gal. of water per hour continuously (or 360,000 gal. daily,) but most of them actually treat 12,000 gal. per hour for four to eight hours per day (or at the rate of 288,000 gal. daily).

A typical plant is that at Scotland, South Dakota, shown in Figs. 2 to 4. Everything is of wood excepting machinery and pipe. The 12-in. drilled well under the pump room is 158 ft. deep and furnishes water to the double-stroke deep-well pump which delivers it through

FIG. 1. TREATED-WATER DISTRICT OF C., M. & ST. P. RY.

6-in. pipe to the waterwheel which does the stirring. After passing the wheel, the water flows to the bottom of the mixing tank. As it rises in the tank it meets in succession the three continuous streams of milk-of-lime, sodium carbonate and ferrous sulphate solutions.

Hydrated lime is used in water treating to extract the carbonic acid, which brings about the precipitation of the scale-making limestone carbonates, down to 3 grains per gallon or less. Sodium carbonate (soda-ash) is used to replace completely the scale-making limestone sulphates by non-scaling sodium sulphate. Ferrous sulphate (green sulphate of iron) is used for the treatment of the last three grains of calcium carbonate so that it will not clog the injector or branch-pipe. This it does by converting half of the calcium carbonate into calcium sulphate.

In these plants the reagents are all fed by regulated streams of water from the pipe which supplies the waterwheel (Fig. 2). The milk-of-lime box, holding 480 gal. of water, carries in suspension enough hydrated lime for a 5-hour supply (at Scotland 400 lb.). This milk-of-lime is fed continuously by a small stream of water entering at the bottom of the lime box and overflowing near the top through a 2-in. pipe to near the bottom of the mixing tank (Figs. 2 and 3). The

drawing shows a lime pump at the top of the lime box, but this is only for emergencies.

Once every hour, an hour's supply of dry hydrated lime is added to the supply in the box. This method produces an hourly variation in the rate of lime feeding, but the stirring by the bars in the mixing tank (Fig. 4) is so thorough and so prolonged (45 minutes) that only a slight variation is found in the water as it overflows from the top of the mixing tank to the bottom of the settling tank.

The dry soda-ash, which is replenished every hour, is placed on a shelf in the soda box and is dissolved by a spray, so that it is fed to the mixing tank as a dilute solution. The sulphate of iron is fed in solution from its box by a small stream which enters at the bottom and overflows near the top.

For feeding any reagent to a treating plant the best method is determined principally by the solubility of the reagent in water. In all cases the thinner the solution or mixture the better. The arrangement of feeding devices described above is not theoretically perfect, but has been adopted as the result of experience in handling railroad plants which are frequently miles from a repair shop and are seldom operated by skilled mechanics. The uniformity of results is the best proof of the efficiency of the design and method.

The water, with its chemical reactions practically complete and its precipitate ready to settle, arrives at the bottom of the settling tank and there commences to leave its precipitate as the water slowly rises to overflow through the perforated collecting pipe (see Fig. 2) to the treated water pump in the pump room, whence it is sent to the track tank (Fig. 3). The two pumps in the pump room are operated by a 10-hp. oil engine, each pump having a clutch on the engine shaft.

Once a day the settling tank is freed of its accumulated sludge by opening for 30 seconds the valves controlling the system of perforated sludge pipes lying in the bottom of the settling tank, and arranged as shown in Fig. 4. The perforations are in the bottom of the sludge pipes, and the branch pipes are connected to the main pipes by street elbows so that they are close to the floor. Heating for the pump room and working room is provided by hot water pipes along the walls. The chemical storage room is of 2½-car capacity.

At Scotland the well water has the general character of all the waters derived from that layer of hard-water sandstone, since the upper layer of soft-water sandstone has run out a few miles away. Our laboratory analysis shows its dissolved mineral content as follows:

	Grains per Gal.
Calcium sulphate	64.9
Magnesium carbonate	19.0
Magnesium sulphate	11.8
Incrusting solids	95.7
Alkali sulphate	9.7
Alkali chloride	2.6
Non-incrusting solids	12.3
Total	108.0

Analyses of the treated water average as follows, it being understood that there are daily variations up to one grain per gallon due to lack of uniformity in the rate of pumping water or feeding chemicals:

	Grains per Gal.
Calcium carbonate	3.3
Sodium hydroxide	0.8
Alkali sulphate	92.0
Alkali chloride	2.6

The chemistry of water softening is very simple in both theory and practice when working on a small scale and with a filter, but when working on a large scale where the resulting water must be settled instead of filtered, certain precautions are necessary. Experience shows that slow and continuous mixing of the hard water with the chemicals for a period varying from 25 to 50 minutes, according to the temperature and clearness of the water, is necessary to complete chemical action. Experience shows also that unless the softening plant is to be encumbered with filters, which would be a very serious drawback to a railroad plant, other special precautions must be taken to insure the perfection of settling.

In the plants built last year on the Chicago, Mil-

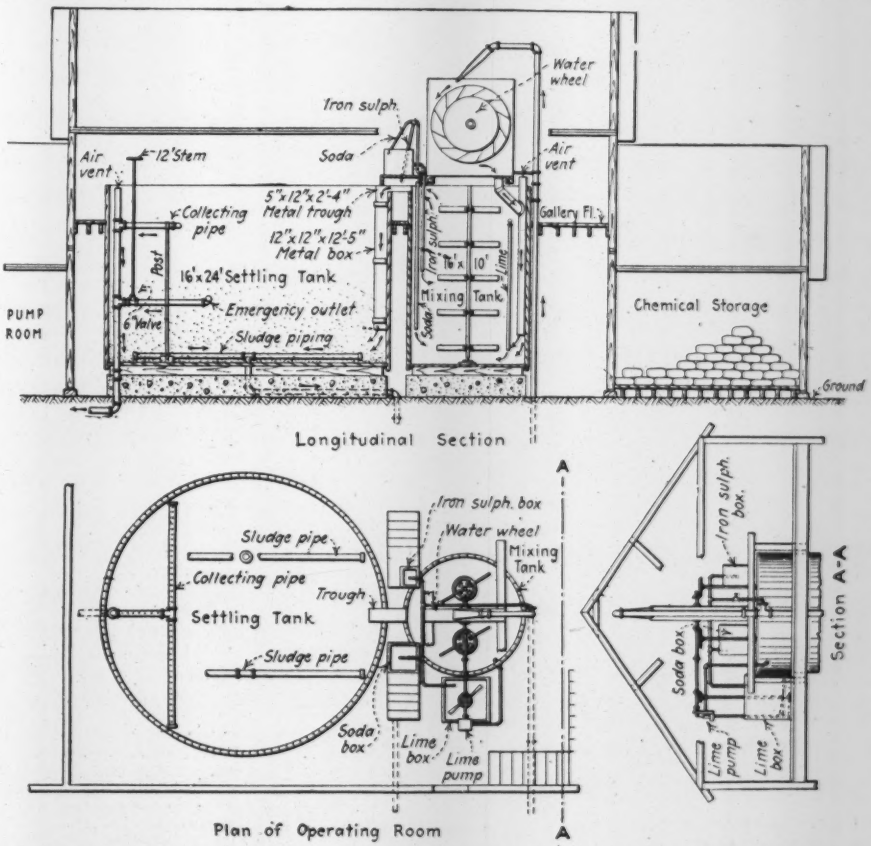


FIG. 2. RAILWAY WATER TREATMENT PLANT AT SCOTLAND, SOUTH DAKOTA.

waukee & St. Paul Ry. the advantage of the 40-min. mixing tank with its continuous but slow stirring is that the precipitate is all formed and ready to settle when the water enters the settling tank. Thus there is none left to form just below the top of the settling tank when it is too late to settle.

Another feature of construction insures a character of precipitate which settles easily. When the chemicals first meet the water the rapidity of chemical action is so great that the particles of precipitate formed are very large and tend to settle quickly. But when the chemical work is nearly done and the few remaining molecules of carbon dioxide meet the few remaining molecules of calcium oxide, the particles of precipitation formed are so infinitesimally small that millions of them make only a bluish cloud which will float for hours. This is the bane of water intended for boilers, because precipitate suspended in the water of the boiler is the cause of the foaming attributed to many treated waters.

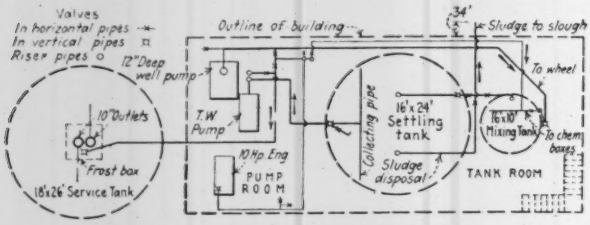


FIG. 3 TYPICAL PLANT LAYOUT

These small particles, at the moment of coming out of solution, commonly called the nascent state, have great adhesive power and will attach themselves to any solid matter within adhesion distance. In the old way of feeding a reaction tank at the top so that the flow was downward, the heavy precipitate has gone ahead and there was nothing for these last and very small particles to attach themselves to. But in the C., M. & St. P. Ry. plants the hard water and the chemicals are introduced at the bottom of the reaction tank and flow upward.

In this way, since the precipitate lags behind the water, the reaction tank soon becomes charged and remains charged with a mass of precipitate to the full sustaining power of the upward flowing current. These infinitesimal particles as fast as they are born attach themselves to the older and larger particles in immediate juxtaposition. The result is that the water flowing from the top of the reaction tank to the bottom of the settling tank carries only comparatively few large particles which settle rapidly and leave the water free from haze.

Since the installation of these treating plants our boilers have been free from scale and from leaking, and almost free from foaming. There has been some foaming, because sometimes one of those little rivers will change the character of its water 10 grains per gallon over night, due perhaps to a rainstorm a week before and a hundred miles away. At times, also, something may go wrong in the plant and the water be undertreated, but when the treatment is correct there is so little foaming that I never hear of it.

As a result of this water-heating system we save in boiler repairs and coal, and we have a much superior service. The last plant has been in operation less than a year and the accounts are not yet made up, but the plants have paid for themselves (and will do so every year) in items of saving that can easily be calculated in dollars.

We have much bad water on other divisions where traffic is more dense, and it is true that the damage to a railroad from bad boiler-water increases with the number of locomotives which use it. But the waters about Mitchell were so very bad and the difficulties of railroading so great that it was decided to utilize our 1920 money in that district. Other increases of quantity and improvement of quality will follow as we can extend our work.

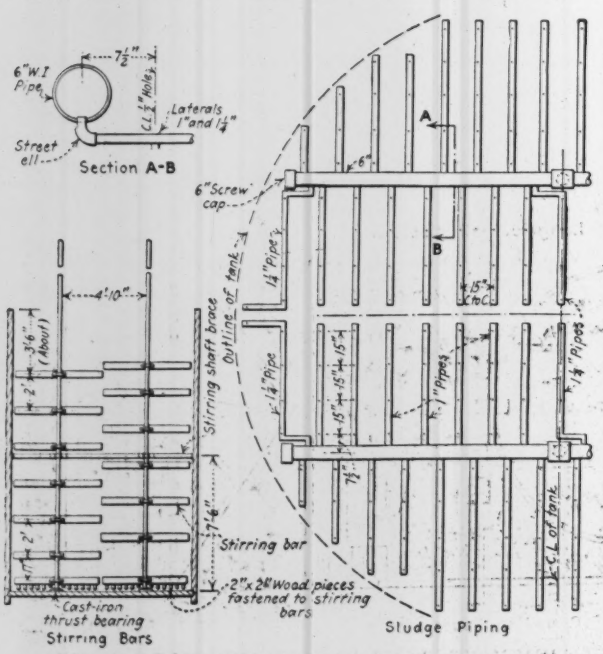


FIG. 4. STIRRING APPARATUS AND SLUDGE PIPES

Port Works and Railways in Chile

The law authorizing the construction of various port works in Chile, together with certain railway works near the town of Constitucion, which are to be constructed only subsequent to the conclusion of definite arrangements for the construction of that port, has been passed. The law as published contains the following provision, according to a recent issue of *Commerce Reports*:

The cost of the various construction contracts shall not exceed the amounts indicated below:

	Pounds Sterling
For Iquique	750,000
For dock and supplementary works in Antofagasta	750,000
For Valparaiso	1,470,000
For Constitucion	900,000
For Talcahuano	920,000
For Lebu	930,000
For Puerto Saavedra	400,000
For Valdivia	1,090,000
For the construction of a breakwater and pier at Puerto Montt	150,000
For the construction of a pier and supplementary works at Pichilemu	40,000
To commence the construction of the railroad from Los Quenes to Curico, of the railroad uniting Parronal to the branch line from San Fernando to Pichilemu, and the continuation of the railroad from Hualane to Constitucion	200,000

Building a Five-Span Concrete Bridge in Cold Weather

Manure Protection Raised Temperature During First 72 Hours — Simple but Effective Methods Used in Placing Protection

By G. F. Scales
General Contractor, Waterloo, Iowa

VERY few complete records of temperatures in cold weather concreting have been published. The accompanying table shows temperatures obtained in the construction of a five-span concrete arch bridge over the Cedar River at Waterloo, Iowa, for the Waterloo, Cedar Falls & Northern Ry., an electric road. This structure, known as the San Souci Bridge, is 30 ft. wide and 440 ft. long, and consists of two 70-ft. spans, two 72-ft. spans, and one 74-ft. span. It is designed for Cooper's E-60 loading.

For handling the work in cold weather a covering of manure was used. The studding was 2x6-in. material and the spaces between the studs were filled, as shown, by nailing just enough cleats and scraps to their outer edges to hold the manure in place. This covering was placed ahead before depositing the concrete, which was heated to approximately 60 deg. in the mixer.

The table of temperatures indicates that there was not more than five degrees loss in temperature during the placing of the concrete. Notice also that the records for 24- and 48-hour periods (after concreting) show that the temperature invariably increased materially. In fact, in some instances temperatures were obtained as high as 118 degrees. The temperatures given in the table are the average of approximately ten holes in each pouring.

The mixing plant consisted of a 9-ft. polygon mixer, with steam power, and a No. 90 Hauck heater, together with a water tank which is heated by direct steam. The rock and sand were not heated except by the hot water and by the heater after they were in the mixer. The average time of mixing was 1½ minutes.

In concreting the arches, the opening at either side was closed with tarred paper and salamanders were placed underneath. The arch faces were covered with manure packed between the studding as above described. The tops of the arches were covered with manure immediately after the concrete was deposited. This manure was very dry, practically all straw, so that there was no seepage of moisture from it to stain the concrete. No undercovering was necessary. No other heat was used to obtain the result shown in the table, although the concrete was placed in temperatures ranging upward from two degrees above zero.

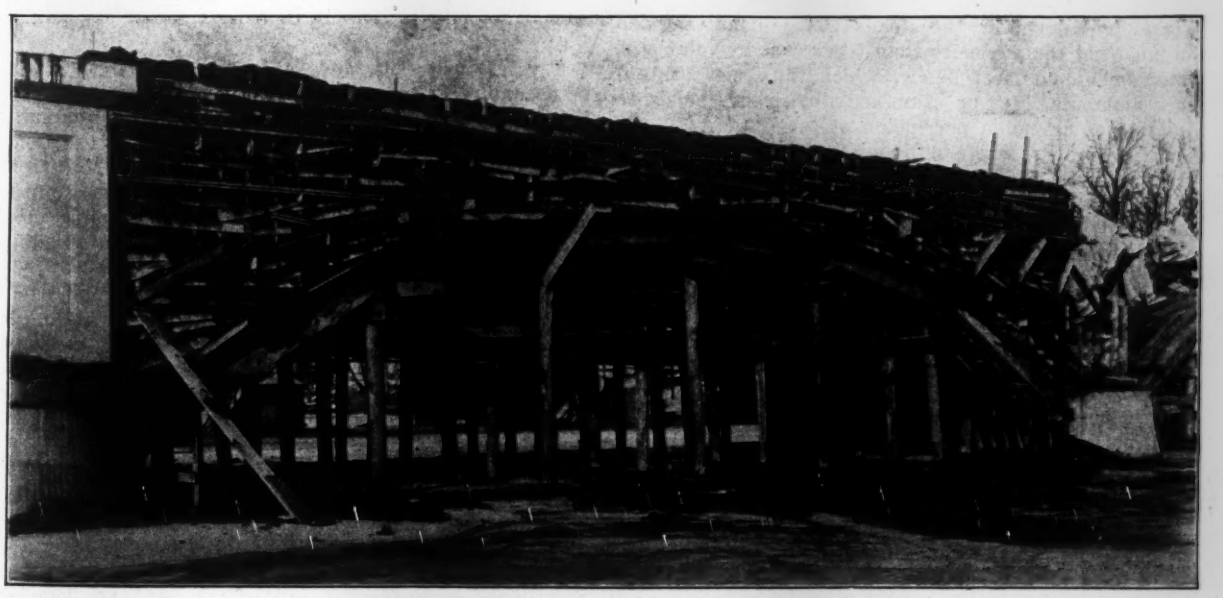
On the spandrel walls the covering was maintained not less than four days, after which the forms were removed and the concrete was found to be set and cured and in perfect condition. The first concrete was placed in Aug. 1921, and the bridge was completed about Feb. 1, 1922.

The writer had the contract for this bridge and the designer was T. E. Rust, chief engineer of the W., C. F. & N. Ry.

RECORD OF TEMPERATURES OF CONCRETE, PLACED IN WINTER IN THE SAN SOUCI BRIDGE, WATERLOO, IOWA

Date of Concreting	Temperatures (Fahrenheit) of Air, Aggregates and Concrete: Outside Air	Sand	Rock	Water	Temperature Record of Concrete: Before Placing	After Placing	After 24 hrs.	After 48 hrs.	After 72 hrs.	After 96 hrs.	Remarks
Dec. 8 1921	34	34	34	100	75	70					Temperature taken at
	35	35	35	113	65	60	90	93	90	85	8 a.m., 12 m. and 3 p.m.
	36	36	36	75	70	65					
Dec. 27 1921	2	34	34	170	64	58					Temperature taken at
	12	34	34	160	62	58	65	71	77	67	8 and 10 a.m. and 3 p.m.
	26	34	34	150	64	58					Concr. mixed 1½ min.
Dec. 28 1921	24	34	34	185	64	63					Temperature taken at
	28	34	34	180	72	65	34	60	58		8 a.m., 9 a.m. and 10:30
	30	34	34	172	63	64					a.m. Conc. mixed 2 min.
Jan. 10 1922	16	30	30	145	61	60					Temperature taken at
	33	34	34	160	64	60	64	65	61	59	9 a.m. and 4 p.m.
Jan. 26 1922	30	30	30	160	63	62					Temperature taken at
	32	34	34	156	66	62	73	79	79	81	9 a.m. and 3 p.m.

Note: The lowest temperature during the actual depositing of the concrete was 2 degrees above zero, and temperature on following day was 10 degrees below zero.



FROST PROTECTION OF MANURE FOR CONCRETE BRIDGE

Practice in Tar Road Construction in Great Britain

Tars and Surface Tarring Procedure—Mixed Tar and Stone Roads—Pitch-Grouted or Penetration Macadam Roads

SURFACE tarring has been applied in Great Britain with advantage to old road surfaces in good condition and to new surfaces which are thoroughly consolidated and dried. The practice is to scrape or brush old road surfaces during the spring months and make good any pot-holes, grooves, waves or depressions, and then to apply the tar by automatic sprayer or by hand, depending on the available labor. This work is now done chiefly by hand, partly on account of the unemployment situation and partly because some road engineers favor the hand method as giving more satisfactory results.

The old road is half or totally closed to traffic before tarring begins and the surface is thoroughly cleansed of caked mud; the sides are strengthened if they have worn thin and, if the road is to be entirely re-surfaced, stone chippings are used to bind in preference to fine material.

The tar used, unless it is a proprietary brand, conforms to one or other of the Roads Department (Ministry of Transport) Specifications. These are known as Tar No. 1, and Tar No. 2.

Specifications of Tar No. 1—This tar was heated to a temperature which will insure that it reaches the road in a highly fluid condition; a boiler specially designed to prevent frothing is employed. The desired temperature in practice is usually found to be between 220° and 240° F.

This tar is derived wholly from the carbonization of bituminous coal except that it may contain not more than 10 per cent of its volume (or distillates or pitch therefrom) produced in the manufacture of carburetted water gas. The specific gravity at 59° F. is as nearly as possible 1.19, but must not be lower than 1.16 or higher than 1.22.

It is laid down by the Roads Department that the tar must not contain more than 1 per cent by volume of water or ammoniacal liquor, which must not contain more ammonia, free or combined, than corresponds to 5 grains of ammonia per gallon of tar.

The amount of water or liquor is determined by condensation from the products of distillation of the tar by cooling with a cold water condenser. Any water so condensed is, after measurement, separated from any light oils present, and the amount of ammonia estimated by direct titration with acid.

On distillation in a liter fractionating flask one-half or two-thirds filled, to conform with the official specification, the tar should yield by weight the proportions of distillates given below:

(a) Below 338° F., not more than 1 per cent distillate (light oils), exclusive of water.

(b) Between 338° and 518° F., not less than 16 per cent and not more than 26 per cent of distillate (middle oils).

(c) Between 518° and 572° F., not less than 3 and not more than 10 per cent of distillate (heavy oils).

The total distillate between 338° and 572° F. must not be less than 24 per cent and not more than 34 per cent, i.e., where the middle oils approach the maximum allowed the heavy oils should approach the minimum, and vice versa.

The distillate between 338° and 518° F. (middle oils) must remain clear and free from solid matter, such as crystals of naphthalene, etc., when maintained at a temperature of 110° F. for half an hour. This requirement may be waived in the case of tar supplied direct from gas works, but tar from which naphthalene has been extracted is preferred to tar in which this constituent is excessive.

The middle oils should not yield to caustic soda solution more crude tar acids (phenol) than 3 per cent by volume of the tar.

The tar should not contain less than 12 or more than 21 per cent by weight of free carbon. This is determined by a complete extraction of the bituminous matter by benzol and bisulphide of carbon; the residue is taken as being free carbon.

Specification of Tar No. 2—This tar is also heated to a highly fluid condition, which has been found to be between 260° and 280° F. For the preparation of tar macadam the tar does not generally require heating to so high a temperature as for surface tarring; the necessary temperature being determined largely by the sensible heat of the stone treated by the tar, and also by the method of application.

This tar is derived from the same source as No. 1 except that it may contain up to 25 per cent by volume (or distillates or pitch therefrom) produced in the manufacture of carburetted water gas. The specific gravity at 59° F. should be as nearly as possible 1.21, but not less than 1.19 or higher than 1.24.

As regards fractionation, the requirements below 338° F. are the same as for Tar No. 1. Between 338° and 518° F. not less than 12 and not more than 18 per cent of middle oils should be distilled; and between 518° and 572° F. not less than 6 per cent and not more than 10 per cent of heavy oils should be yielded.

In the naphthalene, phenol and free carbon tests, the distillate should remain clear for half an hour at 100° F.; the middle oils should not yield more than 2 per cent phenols by volume; and the weight of free carbon should not be less than 12 or more than 22 per cent.

Tar Surfacing Methods—Either of these tars may be used, but if the heavier grade is employed the surface is always allowed to become well warmed by the sun's rays before application. Where hand methods are employed flexible pipes are used to convey the tar from the boiler to the road. As an alternative to these pipes, which are manipulated by hand, 3-gal. pouring cans, with the orifice 1½ in. in diameter and the spout leading direct from the can bottom, are utilized.

As a general rule, in the case of roads tar-treated for the first time, the amount used is one gallon to every 5 or 7 sq.yd. Gritting, if necessary to allow traffic to pass, is delayed as long as possible, and the material used is stone chippings, crushed gravel, coarse sand, or other material free from dust, which must pass a ½-in. mesh.

On heavily trafficked roads a second coat is applied, either over the whole surface or from 9 to 12 ft. in the road center to the extent of one gallon of tar per 8 to 10 sq.yd. This is done two to three months after the first application.

Two or more samples of the tar used are kept in quart tin cans and labelled, showing the locality of

application as well as the specification. The Roads Department has arranged with the National Physical Laboratory to submit a selection of samples to chemical and physical tests for the benefit of road engineers.

Careful records are kept of the road condition in the various seasons, both before and after tarring, and such records show the quality of the tar used, the area covered, the state of the weather during tarring operations, time occupied in these operations, number of men employed and full details of material and labor costs.

Surfacing with Tar Macadam—Before laying a tar-macadam surface, trial trenches are opened at intervals of 450 ft., extending from the road haunch to the center and on alternate sides of the road, so as to ascertain the thickness of the old crust and the state of the foundation.

The thickness of surface coating after consolidation by rolling is as near 3 in. as possible; if a coat thicker than 3 in. is to be laid, the material is applied in two separate coats.

In the case of naturally hard subsoils, not materially softened by infiltration of surface water, the total thickness of the road crust including foundation, if any, is not less than 6 in. after consolidation by rolling. If the subsoil is hard enough to form a good foundation in itself, this thickness is reduced to 4 in. If a clay or other yielding subsoil is located, the thickness exceeds 11 in.

As a rule the crossfall on the finished surface is about 1 in 32. If the crust is not sufficiently thick at the crown to enable this crossfall to be obtained with a new coating of the above thickness, then the old surface is left intact and unscarified, and the new coat made as thick as necessary. If the crust is sufficiently thick the regulation of the crossfall is obtained by scarifying the surface and removing material from the crown to the sides previous to the application of the new coat. The material so loosened is screened and any material finer than ½ in. is discarded.

The broken stone or slag used for aggregate is made up of 60 per cent 2 in. standard gage; 30 per cent 1½ in. standard gage; and 10 per cent ¾- to ½-in. size stone for filling voids during rolling operations.

In the case of two-coated work the sub-crust consists of 2-in. standard gage stone, and the wearing surface 1½-in. standard gage stone; 10 per cent of ¾-in. to ½-in. size stone is then used for void-filling.

The stone is thoroughly dried before coating and, if Tar No. 1 is used, especially in hot weather, the tarred material is allowed to stand long enough for the tarred stone surfaces to become partially hardened and "tacky." If Tar No. 2 is employed, the macadam is laid soon after tarring, and preferably when the road is quite dry and in warm sunny weather.

The amount of tar used per ton of stone, varies from 9 to 12 gal., according to the stone sizes, the grade of tar and the method of mixing.

In most cases a 10-ton roller is employed to finish off the work of an 8-ton roller since less rolling is required than in the case of water-bound macadam.

It has been found advisable to apply a coating of tar to the macadam surface after several weeks' passage of traffic, to the extent of one gallon of tar per 6 sq.yd. This tar is usually No. 2 and is sprayed on at a temperature of 270° F.

Surfacing with Pitch-Grouted Macadam—As in the case of tar-macadam surfacing, the road is opened up every 450 ft. to ascertain the thickness of the old crust and the state of the foundation.

The thickness of the pitch-grouted macadam coat is usually 2 in. on very lightly trafficked roads, and from 2½ to 3 in. on others for single pitch-grouting, and from 4 to 4½ in. for double pitch-grouting.

The thickness of the road crust is made the same as for tar-macadam roads, i.e., 6 in., 4 in. and 11 in. under similar conditions. The cross-fall and the methods of obtaining it are also the same as for tar-macadam roads.

The material for pitch-grouting is broken to 1½ in. standard gage. In addition to this, 10 per cent of chippings of the same stone, varying from ⅜ to ¾ in. is used for closing after grouting with the melted pitch. The pitch employed usually complies with the Roads Department specification as follows, the viscosity being modified to suit climatic and local conditions by varying the quantity of tar oils:

Specification for Pitch—The pitch is obtained of the required consistency by running it off from tar stills in which the distillation of tar has been stopped at a point at which the residual pitch will give a penetration of 70 when tested at 77° F. on a standard penetrometer. Harder pitch is softened or cut back so as to secure this penetration by the addition of tar oils which are preferably a filtered green or anthracene oil, wholly derived from tar produced by carbonization of bituminous coal or from such tar mixed with not more than 25 per cent of its volume of tar produced in the manufacture of carburetted water gas.

The specific gravity of these oils at 68° F. is between 1.065 and 1.085, and they are free from solid matter such as naphthalene and anthracene after standing for half an hour at 68° F.

These tar oils must be commercially free from light oils and water, and must yield at:

(a) Below 338° F. not more than 1 per cent light oils and water.

(b) Below 518° F. not more than 30 per cent middle oils.

(c) Below 626° F. not less than 95 per cent heavy oils, middle oils, and light oils and water, if any.

The pitch is not poured unless the stones are quite dry, which is affected by tarpaulin protection or by the employment of portable blowers. When the material is spread and levelled, it is rolled down dry without chippings until the stones present a mosaic surface.

The quantity of pitch required to grout a single coating is about 1¼ gal. per square yard for a consolidated thickness of 2 in., 1½ gal. for 2½ in., and 2 gal. for 3 in.

In melting the pitch, boilers of from 2 to 3 tons capacity are charged with pitch and about one-half of the proper proportion of tar oils. The fire is kept bright until the pitch reaches a temperature of 300° F. after four or five hours, the other half of the tar oils is then added and the mixture thoroughly stirred. During this heating the firedoors are kept closed. After stirring the doors are opened and the mixture allowed to fall to 250° or 270° F. If bad weather interferes, the fire-door is left open, the damper closed and the mixture allowed to fall to 200° F., at which temperature it is maintained at a consumption of about 7 lb. coke per hour. The boiler is always kept airtight during the melting of the pitch.

The sand used, which is clean and sharp is heated to

400° F. Mixture, in equal parts of sand and pitch, is effected in a separate vessel called a "dandy," and poured into pouring cans of 2 to 3 gal. capacity. During the whole time the matrix (sand and pitch) is continually stirred.

Final rolling is begun immediately after pouring and pushed forward before the matrix has had time to set. The 10 per cent of graded chippings is spread partly before and partly during rollings. Traffic is allowed to pass as soon as the surface has cooled to the normal temperature.

Where the traffic is heavy enough to demand double pitch-grouting, the bottom layer is made the thicker and consists of large stones, the two layers being rolled down and grouted separately. The stone for the bottom layer is graded from 2 in. to 3 in. standard gage, and no chippings are used for finishing the rolling of the bottom coat. The stone for the top layer is 1½-in. gage, and is finished with chippings graded from ½ to ¼ in.

So as to provide a key for the top layer the pitch is poured until about ½ in. of the stones is left exposed. The pitch used for double pitch-grouting is 3¼ gal. per square yard, with a thickness of 4 in., and 3½ gal. for 4½ in., though these quantities are sometimes varied for different materials.

Filtered Well Water Recommended for Memphis, Tenn.

After Iron and Carbonic Acid Removed Well Water Is Softer, Cooler and Produced Cheaper Than Filtered Mississippi

WELL water freed from carbonic acid gas and iron by aerators and filters rather than filtered Mississippi River water is the recommendation of Fuller & McClintock, consulting engineers to the Board of Water Commissioners of Memphis, Tenn. The well supply is good for 75 m.g.d. and will meet the demands for the next 30 years. The city now uses 13 m.g.d., derived principally from the Auction Ave. Station, which is 30 years old and near the end of its useful life. Costs are high, the service is becoming more and more unreliable, and dangerous pollution by leakage from sewers constantly menaces the supply. Though the artesian water is soft, free from bacteria, clear, cool and palatable, it contains 90 to 130 p.p.m. of CO_2 and an iron content varying from 0.2 to 6.0 p.p.m. The CO_2 takes up iron from the pipes, making storage, needed for fire protection, impracticable, unless the iron and CO_2 are removed.

FUTURE WATER REQUIREMENTS OF MEMPHIS

Year	Estimated Population	—Rates of Consumption m.g.d.— Ave. Day	Max. Day	Max. Hour	Max. Day Including Fire Draft
1920	162,351	13	20	27	36
1930	203,000	18	27	37	44
1940	249,000	24	36	50	55
1950	299,000	31	47	65	67

It is proposed to sink 24 wells having capacities of 1 m.g.d. each and install an 18-m.g.d. aeration and filter plant. The principal reasons given in the report for choosing the artesian supply rather than river water are as follows:

The water would be much harder than the artesian supply and also appreciably warmer in summer. Filtered river water would be free of iron and free carbonic acid in quantities which would seriously corrode iron. It would be far cheaper to treat the artesian supply by aeration and filtration to remove iron and carbonic acid than to remove the silt and bacteria from the river water.

A satisfactory intake in the Mississippi River from which to obtain a city water supply is more difficult and expensive to obtain under local conditions than at New Orleans or St. Louis. To establish such an intake in the vicinity of the bridges where the channel is stable would be objectionable on account of the city sewage, which could be removed only at great expense by intercepting sewers. To locate an intake twenty miles or more north of the city where the channel and banks are stable would be prohibitively expensive.

The only safe and permanent location for an intake pier, which could be built at reasonable cost, is opposite Poplar St., 1,500 ft. from the Arkansas shore, in deep water, in order to guard against trouble from deposits. From such an intake a tunnel would be built to a reservoir and filtration works at a site, 20 acres in area, located in the general neighborhood of Quinby Bayou and Winchester Ave. For a complete river water project of a rated capacity of 24 m.g.d. estimates for construction costs are $5,080,000, and the average annual cost would be $549,400.

This river supply investment is nearly double that required for a first class modern artesian water development of equal capacity, including aeration and filtration works, 10-m.g.d. storage reservoir, complete new pumping station and all necessary piping connections and extensions to satisfy the insurance authorities. The annual cost, including capital charges, depreciation, operation and maintenance, for a river water supply is about $200,000 in excess of the corresponding annual costs for a complete artesian development.

Treatment—The carbonic acid content is greatly reduced by the air-lift method of pumping water from the wells, about 80 per cent being removed. However, it has been proved conclusively by experiment and by observation of air-lift installations in various parts of the city that when iron is present the water becomes permanently milky in appearance on storage. To prevent corrosion in street mains and consequent increase in iron content, the carbonic acid should be reduced to 10 p.p.m. or less, which result can be obtained by additional aeration through nozzles, coke beds or other devices and by the application of small quantities of quick lime. The iron can be removed readily and completely by passing the water through rapid sand filters at normal rates for mechanical filters and can be completely removed from fully aerated water by such means only.

Air-Lift—Air lifts are best for removing the well water and delivering it through the collecting conduit to the proposed treatment plant at Dunlap St. Electrically-operated deep well pumps are somewhat more expensive and do not show the advantage which the air lifts possess in removing 80 per cent of the CO_2. Air for lifting the water and delivering it to Dunlap St. will be furnished by four compressors, two for regular service and two for reserve, each having a capacity of 2,700 cu.ft. of free air per minute. The compressors would be of the horizontal, cross compound, high-duty type, designed for a maximum pressure of 80 pounds.

Secondary Water Motor Pumps—For lifting the well water 20 ft. to the aerating and filtration works it is proposed to install centrifugal pumps operated by water motors attached to the high-service pipe system, this being the cheapest arrangement. In the event of a very severe conflagration it is possible to by-pass the filter works by shutting down these pumps, but this would not be necessary with any fire such as Memphis has ever yet experienced.

High-Lift Pumps—The best arrangement would be to provide two 15-m.g.d. crank-and-fly wheel engines and three 15-m.g.d. turbine-driven centrifugal pumps, the two former being capable of supplying the secondary pumps and 95 per cent of the water used by the city until 1930. The centrifugal pumps would be used during peak rates of pumpage and when the reciprocating pumping engines are being repaired.

Other types of pumping equipment considered and rejected as inadvisable were electrically-driven pumps not only for lifting water from the wells but also for delivering

water at Dunlap St. from the storage reservoir into the distribution system. No economy was found in electric pumping equipment, regardless of whether power be purchased or generated at the Dunlap station. We are particularly adverse to recommending electricity where there is no stand-by source of power quickly available in case the primary current should be shut off. In the case of this waterworks plant, there is no opportunity for storage of pressure water, and no interruption in the full necessary pumpage at the Dunlap St. high service pumps can be tolerated.

Wells—Eighteen wells at 1 m.g.d. each are required for service and five are required for reserve to permit of repairs. The best spacing, considering relative costs of conduit and extra head caused by interference is 500 ft. The economic size, considering the relation between the first cost of wells and fuel cost of overcoming friction in well casing, is 12 in. in diameter. The average submergence is 70 per cent; operating air pressure at well, 73 lb. and station pressure 78 pounds.

Air—The estimated free air requirement is 300 cu.ft. per min. per m.g.d., or 0.43 cu.ft. per gallon. This is conservative as compared with the Rix formula, which applied to our condition gives 0.28 cu.ft. per gallon.

Spillway of Elephant Butte Dam Completed

THOUGH the Elephant Butte Dam, Texas, was about completed in 1916, the construction of the spillway was postponed until the height of the stored water was such that it could be used to advantage in excavating the spillway hydraulickally. The accompanying photograph taken recently by L. R. Fiock, assistant engineer, U. S. Reclamation Service, Rio Grande Project, shows the spillway in its relation to the main dam.

In arriving at the final design, after consideration was given to curved channels and a series of check weirs, a straight channel was decided upon as best fitting the geological formation and the high velocities which would result down the steep slope from the dam to the river. The section adopted has a width of 50 ft., is from 20 to 25 ft. deep, and has an estimated capacity of 30,000 sec.-ft. The upper or curved sections of the walls, which act as turning walls, are of gravity type, while the straight section is designed with cantilever backfilled walls.

Concrete was placed from a chuting tower 135 ft. high. Approximately 36,000 yd. of material was excavated and 7,785 cu.yd. of plain and reinforced concrete placed.

The design and construction were carried out under the direction of L. M. Lawson, project manager, Rio Grande Project, U. S. Reclamation Service.

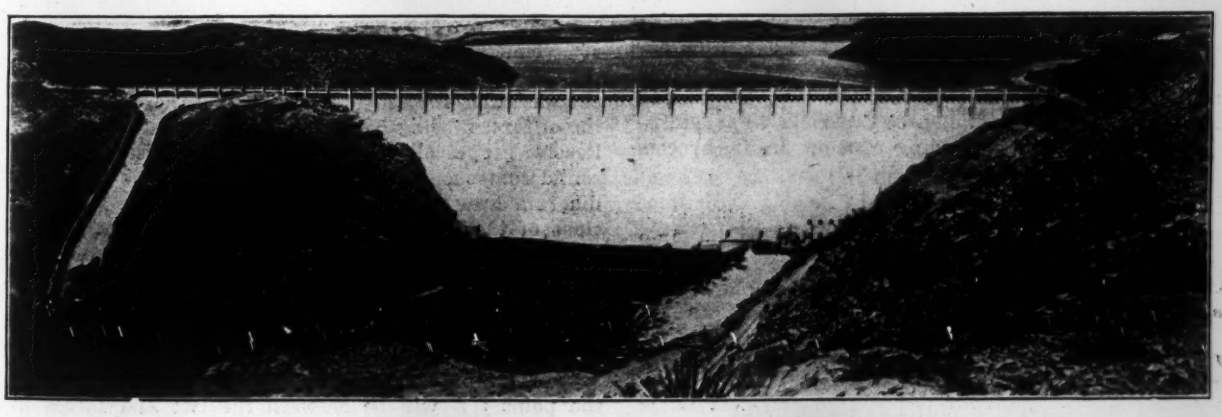
Comparative Strength of Air-Dried and Kiln-Dried Wood

FROM 150,000 comparative strength tests of kiln-dried and air-dried wood of 28 species the engineers of the Forest Products Laboratory conclude that there is no difference in strength. The ordinary fallacy that kiln drying produces stronger wood than air drying is usually the result of failure to consider differences in moisture content. The moisture content of wood on leaving the kiln is generally from 2 to 6 per cent lower than that of thorougly air-dried stock. Since wood rapidly increases in strength with loss of moisture, higher strength values may be obtained from kiln-dried than from air-dried wood. Such a difference in strength has no significance since in use a piece of wood will come to practically the same moisture condition whether it is kiln-dried or air-dried.

The appearance of the dried wood is not a reliable criterion of the effect the drying process has had upon its strength. The strength properties may be seriously injured without visible damage to the wood. Also, it has been found that the same kiln-drying process can not be applied with equal success to all species. To insure uninjured kiln-dried material, a knowledge of the correct kiln conditions to use with stock of a given species, grade and thickness, and a record showing that no more severe treatment has been employed, are necessary.

Steel Powder as a Concrete Content

In 1920 the Queensland Railway Department undertook a series of experiments looking toward the discovery of a formula for obtaining an impermeable concrete with which to reinforce concrete reservoirs. The results of these experiments were recently explained in a conference at Brisbane, in which it was stated that the use of a steel powder not only rendered the mortar or concrete more impermeable but added to the resistance and hardness of the mix. It is recommended for use in concrete placed in either fresh or sea water because the metal seems to fix the cement and cut down the chemical action of the water. The sand used in the mix should be chosen with the greatest care. Half as much steel dust, which replaces part of the sand content, is used as is cement in any particular mixture. Care must be exercised in the mixing, and the consistency should be, according to the bulletin describing the experiments, "semi-liquid."



ELEPHANT BUTTE DAM WITH RECENTLY COMPLETED SPILLWAY

Bending Moments in Pins or Shafts Determined Graphically

Effect of Forces in Different Planes Expressed by Composite Moment Diagram—Maximum Movement Found by Inspection

BY A. M. WINSLOW
University of Washington, Seattle

FOR a pin connecting structural members or machine parts and supporting several non-parallel forces, the customary method of finding the bending moment by numerical computation is rather long and tedious. The following graphical method is usually much shorter, particularly in cases where the value of the bending moment is required at more than one point or where the point of maximum moment cannot be determined readily by inspection.

Graphics of Parallel Forces—The graphic method will be explained by considering first the simpler case of parallel forces, for which the well-known graphical construction will be given here in order to make clear the extension of this method to the more complicated case of non-parallel forces. In Fig. 1, *rv* represents to scale the axis of a horizontal member with the set of vertical forces V_1, V_2, V_3, V_4, V_5 applied as shown. In the force diagram the forces are laid off in succession on a line *be*. According to the usual notation, the length *bc*

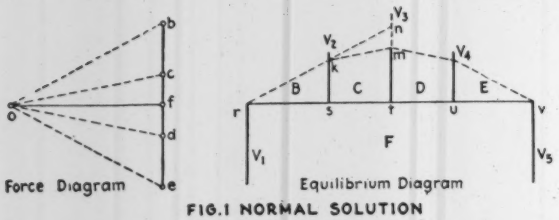


FIG. 1 NORMAL SOLUTION

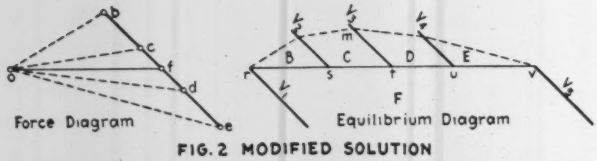


FIG. 2 MODIFIED SOLUTION

FIGS. 1, 2. MOMENT DIAGRAMS FOR PARALLEL FORCES

represents to scale the force included between the large letters B and C in the equilibrium diagram. Next, from *f*, the point between the two end forces, *fo* is drawn parallel to *rv*. From *o*, any convenient point in *fo*, the lines *ob*, *oc*, *od*, *oe* are drawn. Then, in the equilibrium diagram, starting at *r* on the axis, *rk* is drawn parallel to *ob*, *km* parallel to *oc*, and so on. In this last construction it will be noticed that the line in the space B is parallel to *ob*, in the space C parallel to *oc*, etc.

At any point *t* the bending moment M_t is, by computation,

$$M_t = V_1 \times (tr) - V_2 \times (ts)$$

From similar triangles *nrt* and *bof*,

$$\frac{(tn)}{(fb)} = \frac{(tr)}{(fo)}$$

$$(fb) \times (tr) = (tn) \times (fo)$$

$$V_1 \times (tr) = (tn) \times (fo)$$

Likewise, from similar triangles *nkm* and *boc* it can be shown that $V_2 \times (ts) = (mn) \times (fo)$

Therefore,

$$M_t = (tn) \times (fo) - (mn) \times (fo)$$

$$= (tm) \times (fo)$$

Expressed in general terms, in Fig. 1 the bending moment at any point *t* is equal to the product of the intercept *tm* multiplied by *fo*. The former, *tm*, represents a length in inches and should be measured by the same scale as the length of the member *rv*, while *fo* represents a force in pounds and should be measured by the same force scale as *bc*.

Before proceeding to the more complicated case of non-parallel forces, a modification of the method of

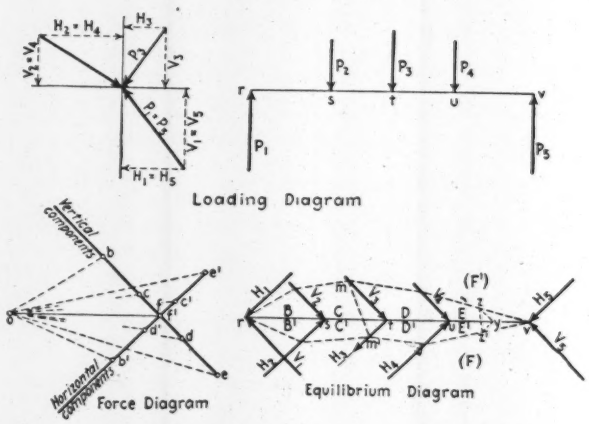


FIG. 3. COMPOSITE DIAGRAM FOR PIN SUBJECTED TO FORCES IN DIFFERENT PLANES

Fig. 1 will be explained. In Fig. 2 assume the same horizontal member *rv* and the same *vertical* forces V_1, V_2, V_3, V_4, V_5 as in Fig. 1. In Fig. 2, however, instead of representing these vertical forces in their true direction, let them be drawn parallel to each other, but inclined at an angle to the axis, as shown. Now draw the force diagram and complete the equilibrium diagram in the same manner as in the preceding figure, noting that *fo* is drawn parallel to *rv*. Then, by precisely the same reasoning as before, it may be shown that, in Fig. 2,

$$V_1 \times (tr) - V_2 \times (ts) = (tm) \times (fo)$$

In other words, in Fig. 2, the product of the intercept *tm* multiplied by *fo* gives the value of the bending moment at the point *t* for parallel forces *perpendicular to the axis.*

Non-Parallel Forces—The above preliminary explanation will make clear the principles involved in the graphical solution of the general case of non-parallel forces perpendicular to the axis, which will now be considered. To make the explanation brief, a simple case of symmetrical loading will be assumed. In Fig. 3, the loading diagram shows the axis of a pin *rv* with perpendicular forces P_1, P_2, P_3, P_4, P_5, the directions of these forces being shown at the left of the figure. Resolve graphically each force *P* into vertical and horizontal components, *V* and *H*. Then, in the equilibrium diagram draw the axis *rv* to scale and indicate the directions of the vertical components parallel to each other, but inclined to the axis at an angle of about 45 deg., similar to Fig. 2. Indicate the directions of the horizontal components at right angles to the vertical components.

Draw the force diagram, starting at the intersection *f*, *f'* to lay off the *V* and the *H* components, so that the point *f*, *f'* will be between the two end forces in each case. Draw *fo* parallel to *rv*, and complete the

force diagram and the equilibrium diagram for both the V and H forces, in the same manner as in Fig. 2.

Then, in the equilibrium diagram of Fig. 3, since the intercepts tm and tm' are at right angles, mm' is the resultant intercept, and the value of the bending moment at the point t is

$$M_t = (mm') \times (fo)$$

It can now also be quickly determined whether the maximum bending moment occurs at t or at s. Moreover, if the value of the bending moment is required at any intermediate point y in the span, draw the intercepts yz and yz'; then

$$M_y = (zz') \times (fo)$$

In certain cases this graphical process can be shortened somewhat. For example, where the loading is symmetrical about the middle of the span, as in Fig. 3, it is of course necessary to draw the equilibrium diagram for only one-half of the span. Also the multiplication $(mm') \times (fo)$ may be simplified by a suitable choice of the length of fo. This choice of fo may be conveniently made as follows in cases of pins of moderate length. A principle is involved regarding the scales of mm' and fo. As noted previously, any intercept mm' should regularly be measured by the same scale of length as rv, while fo is measured by the force scale of the force diagram. In the product $(mm') \times (fo)$, however, the result will obviously be the same if these scales are interchanged, that is, if mm' is measured by the force scale and fo is measured by the scale of rv. With pins of moderate length, it is usually convenient to draw the span length rv full-size and also make the actual length of fo one inch. Then, interchanging the scales as just noted, if the intercept mm' is measured by the force scale in pounds, the scale reading is directly the value of the bending moment in inch-pounds.

Suspended Ceiling Specifications Suggested

IN ORDER to co-ordinate the practice of design of suspended ceilings of metal lath, the Associated Metal Lath Manufacturers have issued the following specifications for that type of construction.

Hanger—The vertical member which carries the steel framework.

The minimum size for hangers shall be No. 8 galvanized wire 1 5/16-in. flats or 7/32-in. round mild steel rods. The wire is to be attached by twisting three times—flats attached by bolting with 3/8 bolts—rods by twisting twice, or by right angle bends and wiring. They shall be spaced not to exceed 4 ft. centers in either direction.

Runner Channel—The heaviest horizontal member.

Runner channels are to be not less than 1½-in. channels with a minimum of 0.442 lb. per lin.ft. They shall be spaced not to exceed 4 ft. on centers.

Furring Channel—The smallest horizontal member, to which the lath is attached.

Furring channels shall be not less than ¾-in. channels iwth a minimum weight of 0.276 lb. per lin.ft., attached to runner channels by at least three loops of No. 16 galvanized wire at each crossing. They shall be set on various centers, depending upon the lath to be used. A maximum of 11¾ in. centers shall be used for 3-lb. flat lath, 15¾-in. centers maximum for 3.4 lb. flat lath, 19-in. centers maximum for 3 lb. rib lath.

Metal Lath—The plastering base and reinforcement.

Metal lath shall weigh not less than 3 lb. per square yard. Metal lath shall be attached to the furring channels by No. 18 gage annealed galvanized lather's wire, every 6 in. along the furring channels.

Laminated Floor Tested for Influence of End Joints of Plank

By E. O. Ericson
Cumberland, Md.

IN THE construction of a laminated plank floor for a tire factory building recently, the question arose to what extent the floor is weakened by the end joints if individual plank do not run across the full span between girders. Such a floor consists of strips of wood ranging from 2 x 4 to 2 x 10 or deeper, laid on edge, each strip thoroughly nailed to the preceding one. The top of the floor thus built is smoothed off by adzing and a top floor then laid over it. Common practice in building such floors is to use pieces long enough to reach from girder to girder, which makes the floor rather costly and causes trouble in getting a large number of pieces of the same length, especially where the span is more than 16 ft. It is much more convenient to use random lengths. As no method of calculating the strength of a floor having joints within the span was known, an actual test was made. The results of the test were so satisfactory that all the floors of the building were constructed like the test sample, with plank joints making up as much as one-third the total cross-section.

Spans of 20 ft. and a floor load of 400 lb. per square foot were contemplated. Counting the full cross-section of the floor (under the common practice of using pieces of such length as to reach from girder to girder), a floor thickness of 10 in. was required, at an allowable fiber stress of 1,200 lb. per square inch. Therefore, 2 x 10 planks 20 ft. long would have to be used. In order to reduce cost and expedite the shipping of the lumber, however, it was desired to use random lengths, which would involve joints within the length of a span.

The test was made on a section 2 ft. wide extending over three 20-ft. bays. The material was 2 x 10 long-leaf yellow pine, dressed on four sides, with ¼-in. chamfer on each corner. The lengths ran from 10 to 20 ft., and they were so arranged that every third strip was of the same arrangement as regards joints. The 2-ft. width was made up of fifteen planks, of which five broke joint at the center of the middle span and five near the end of this span, while in the two end spans the three sets of joints came at various positions but not at the middle of the span. The nailing consisted of two 20-penny wire nails vertically one above the other, every 18 in. along the length of a plank.

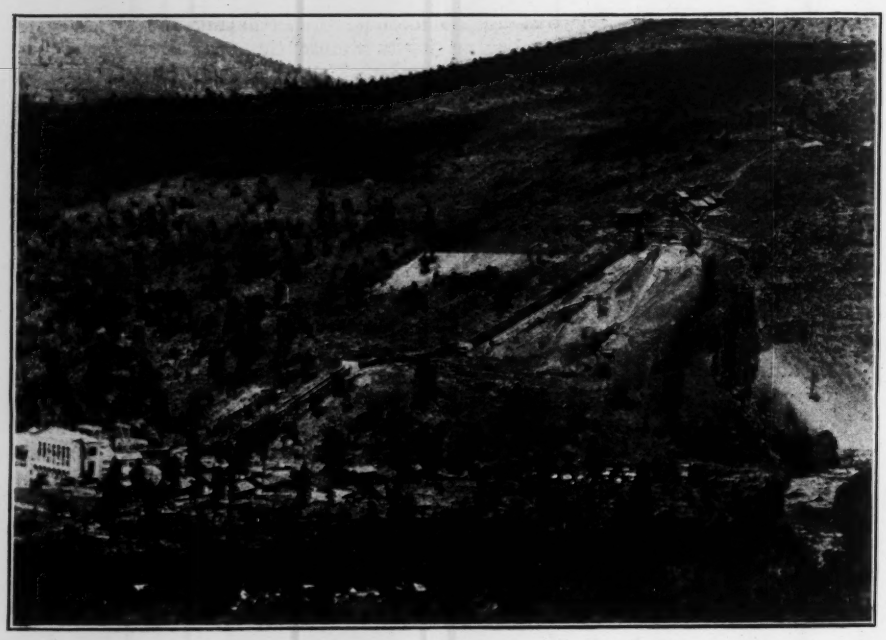
For the test the middle bay was piled with bricks in individual piles, slightly separated to avoid arching as the floor deflected, and as each layer of brick was put down the deflection of the middle section was measured. These deflections amounted to about ¾ in. at 500 lb. per square foot, 1½ in. at 1,000 lb. per square foot, and 2 5/8 in. at 1,500 lb. per square foot. At a load of 1,587 lb. per square foot a fracture occurred in the sixth board from one side, at the center point of the middle bay. Loading was continued, however, to 1,700 lb., with a total deflection of 2 7/8 in., and this load in two days produced no further deflection.

A working load of 400 lb. per square foot on such a floor would give a factor of safety of 4, according to the test. Since a complete floor has greater strength because of the fact that each section is supported by the section to either side of it and because of the maple top floor, it was decided that the factory floors could be safely built like the test section.

First Pit River Power Project Is Completed

Highest Unit in Continuous River Development Totals 90,000 Hp.—220,000-Volt Power Line 202 Miles Long

A FORMAL opening Sept. 30 marked the completion of Pit River project No. 1, the first large unit in a series of hydro-electric plants being built on the Pit River in northern California by the Pacific Gas & Electric Co. The series of several plants to be built on this stream will use the same water successively in developing a total of about 600,000 hp. Pit No. 1, which stands at the upper end of the series, is notable for the size and head on the reaction wheels installed—45,000 hp. units under a 454-ft. head—but a still more remarkable feature is the watershed whose uniformity of stream flow has justified extensive construction designed to handle a flow of 1,800 sec.-ft. without the provision of any artificial storage whatever. A map and profile, together with general descriptions of the Pit River series of plants and the construction of thirty-five miles of railroad to Pit River No. 1, appeared in *Engineering News-Record*, Oct. 13, 1921, p. 604.



GENERAL VIEW ON PIT RIVER NO. 1 PROJECT

Surge chamber not yet completed. Note precipitous drop at right where flume will convey overflow from surge chamber. Tunnel dump shows at left and crusher plant on right at top of penstock.

Pit No. 1 takes its water from Fall River, a tributary of the Pit, only 15 miles long, but which springs full-fledged, as it were, from the lower edge of the Modoc lava beds. These beds of porous formation occupy a wide more or less level plain, seventy-five miles long, in which there are no surface streams. The extent of their stabilizing effect on the runoff, as shown by the uniform flow of Fall River, is such that seasonal variations are almost entirely eliminated. The maximum fluctuation of the river level on record is considerably less than one foot. In the city of Fall River Mills, near the intake, there is a historic island whose surface averages but 1 or 2 ft. above normal water level and which has on it a flourishing garden and orchard surrounding a residence built many years ago with the floor only 3 ft. above water level.

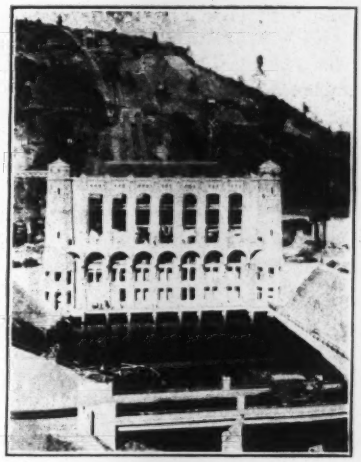
With the exception of the first part of the tunnel work, practically the entire project has been built in the year since the completion of the railroad. Prior to that time mud and snow made the main camp almost inaccessible for seven months of the year and all work was done under difficulties. Within the past year, however, the construction forces have included as high as 2,000 men. Rapid progress was made on all parts of the work and construction was completed according to schedule.

During the year the diversion dam in Fall River has been started and finished, the intake canal involving the removal of 80,000 cu.yd. has been excavated and lined with riprap and the 10,111-ft. tunnel has been completed and concreted. On the lower end of the project excavation for the power house foundation was started less than a year ago. Since then the building has been completed, a 1,200 ft. tailrace which involved a 120,000-cu.yd. excavation has been built and lined with riprap, and two 1,375-ft. steel penstocks and a concrete surge chamber have been constructed, not to mention the installation of all electrical equipment, including the outdoor transformer bank and about 150 miles of 220,000-volt steel tower lines. Installation of equipment in the power house was carried on simultaneously with the erection of the structure itself.

Pit No. 1 is a compact project; from the diversion on Fall River to the discharge into Pit River at the end of the tailrace the water travels but little over 2½ miles. Because of irrigated areas above and the necessity for avoiding any change in water levels, the intake dam is chiefly a submerged structure, 600 ft. long, with its crest but little above normal river level. It has three radial gates for emergency use in letting water through the dam. Entrance to the intake canal is at right angles to the stream flow at the west end of the dam and is controlled by three 10 x 20-ft. radial gates. The setting for these gates was combined with a highway across the canal in a single concrete structure with the motors for operating the gates installed on a second level of floor just below the roadway.

The intake canal, 1,200 ft. long, is designed to carry 1,800 sec.-ft. at a velocity of 2.8 ft. per second. To prevent caveins the side walls were lined with masonry from intake to tunnel portal. Materials excavated from the tunnel were crushed to provide rock and sand for the concrete tunnel lining which was placed by the pneumatic process. Crushing plants were installed at both portals of the tunnel. The one on the lower end

also supplied aggregate to make the concrete for the power house. Storage piles of material ready for the power house were made on the steep sidehill below the tunnel portal, whence delivery to the power house mixing plant could be made by gravity as required.



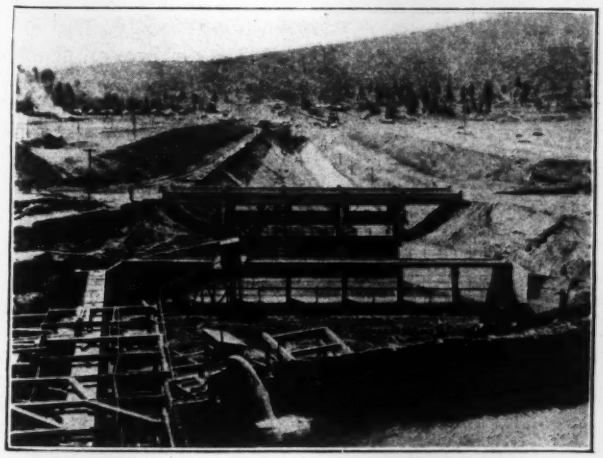
PIT RIVER POWER HOUSE

Turbines discharge into stilling basin whence canal 1,200 ft. long leads into Pit River. Forms not yet removed from circular spillway section on surge chamber at top of penstock line.

The surge chamber is a structure of massive design, 55 ft. high and 60 ft. wide inside, uniting the lower end of the tunnel with the double penstock line. It is designed to spill over the circular top and into a canal which discharges over a precipitous cliff nearby. Each penstock is equipped with a remote control, motor operated, butterfly valve, 10 ft. 9 in. in diameter, located near the surge chamber. Just below these valves at the top of the steep slope are placed 36-in. stand pipes for air venting the penstocks. At their lower ends the penstocks pass beneath the switch house and into the wheel pits via two 15-ft. concrete-lined tunnels.

The two hydraulic units are Allis-Chalmers single runner vertical reaction turbines, rated at 45,000 hp. each, equipped with hydraucone regainers and driving 35,000 kva. generators. The stilling pool just below the power house has been provided with an accurately leveled knife-edge weir 120 ft. long which is to be used in connection with hook gages installed in protected wells alongside for measuring discharges accurately.

In keeping with recent California practice all transformers are placed outdoors on concrete foundations, thus decreasing the size of the structures required, but by means of convenient track connections into the building, the equipment is kept within easy reach of the power-house cranes.



VIEW FROM FALL RIVER DIVERSION DAM TOWARD TUNNEL

Earth barrier in foreground was last of canal excavation to be taken out. Tainter gates located under highway bridge. Canal lined with hand-placed riprap.

Many electrical problems of a pioneering nature had to be worked out in preparation for the use of 220,000 volts on the transmission lines which will lead from Pit No. 1 202 miles to Vacaville, the distribution center not far from San Francisco Bay. The full voltage is not to be employed at the outset. The first operation will be at 110,000 volts over two parallel circuits, one of which will be used as a reserve. Later one of the circuits will be tested out at 175,000 volts, after which the voltage on the other circuit will be raised to 220,000.

The construction of Pit No. 1 has been done by the company's own forces. O. W. Peterson is construction engineer and E. H. Steele in charge of line construction.

The Engineer

From the Winnipeg "Tribune," Sept. 7, 1922

THE fact that the Engineering Institute of Canada is in convention here makes the occasion opportune to pay a little tribute of praise to one of the most essential and one of the least appreciated of the professions.

Study almost any phase of modern life, and at the bottom will be found an engineer. When we learn to recognize the engineer, and value his services at their true worth, the world will make much more rapid progress and at the same time a great profession will come into its own.

Great trains shuttle back and forth across the continent, thundering their contempt for the roadbed that plays a humble but essential part in transportation. Somewhere a long time back an engineer hacked his way through the bush or tramped over the lone prairie, surveying the line. After him came another engineer, blasting and digging and filling until the roadbed was made and the steel laid. Other engineers were creating the machinery that constructed the locomotive and the cars, and they were made from steel. Engineers had found the iron ore, engineers had mined it, engineers had turned it into steel with the aid of chemical engineers and electrical engineers and many others.

We say casually that Canada has 18,000,000 available horsepower in hydro-electric energy. How do we know? Engineers of the hydrographic branch have been ranging the whole Dominion, measuring the flow of rivers, many of them in the almost inaccessible fastnesses of the hinterland. Engineers first surveyed the course of the rivers, and when the time comes when hydro-electric development is possible on any of them, engineers will choose the site, engineers will construct the dams and the power plants and the transmission lines. The development of the hydro-electric power of Manitoba is one of the greatest factors shaping the destiny of this province and its people.

A great bridge costing many millions of dollars is to be erected. Engineering brains must figure the stress and strain on each little strut or girder, even each both in the structure. A highway is planned—engineers must figure gradients and drainage and materials and construction. A great building is to be erected, and engineering accuracy is called to find out what foundations are necessary. A city requires water, and the engineer is the man who finds it and brings it in and distributes it. Does concrete work crumble under the action of alkaline water? Turn to the engineer. What radiation is necessary to heat a space of 200,000 cu.ft.? Ask the engineer. What is the wind stress against a great illuminated sign high in the air? Consult an engineer.

The engineer is the brains of construction and development. The capitalist supplies money, the workingmen supply labor, the management furnishes direction and initiative. The engineer's job is to say what can be done and how it can be done—and he must know, for guesswork is foreign to his nature.

It is a noble profession, and one of the greatest. Let us hope that greater recognition will come to it.

Methods and Cost of Laying Gas Main with New Joint

Deep Bell Joint Packed with Cement and Yarn—Hand Trenching and Backfilling—Large Bell Holes Facilitate Calking

By Jacob D. von Maur

Superintendent of Distribution, Laclede Gaslight Co., St. Louis, Mo.

A TWENTY-FOUR-IN. high-pressure gas main laid recently at St. Louis, Mo., is believed to be the first high-pressure main laid with pipe having the No. 2 or alternative design of bell for cement and combination joints adopted by the American Gas Association in 1913 and revised in 1922. This bell and the standard bell are shown in the accompanying drawing. It will be noted that in the No. 2 bell the depth is much greater, the lead groove is omitted and the bell is tapered so that the lead or cement space is greater at the back. Thus in the 24-in. pipe the bell is 6 in. instead of 5 in. deep and the lead space increases from 0.63 in. to 0.75 in. at the back instead of having a uniform width of 0.63 in. The weight of the new bell is thus 259.5 lb. instead of 235.1 lb. in the standard design. This main is 1,000 ft. long and forms part of the high-pressure belt line which is a distinctive feature of the St. Louis gas distribution system. Of the total length, 900 ft. are laid with pipe having the new joint and 100 ft. with pipe having the old standard bell and spigot joint.

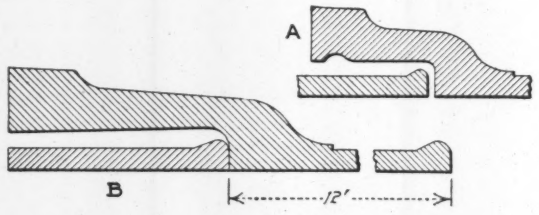
In order that the joint made with the No. 2 bell should be given the best possible test no expense was spared to lay this main as nearly perfect as possible. The bell and spigot were carefully cleaned with wire brushes and each length of pipe was laid on wood blocks set flush with the bottom of the trench, so that the pipe has a bearing on the ground as well as on the blocks. The bell holes were made unusually large so that the calkers had ample room to work comfortably. Jute packing, free from oil, was used in the joints. The first yarn was dipped in water and then thoroughly squeezed so as to leave it just damp. Four strands were first placed in the joint and thoroughly calked with heavy yarning irons driven with hand calking hammers. The pipe was well set by filling and tamping the earth between the joints.

After six lengths of pipe were laid the joints were finished by filling the space between the spigot and bell with neat cement, hand mixed with water in the proportion of 10.5 quarts of cement to 4.5 quarts of water. The proportion of water to cement (45 per cent) is somewhat more than theory calls for, but with weather conditions the hottest of the year this proportion appears to be about right. When the joint was filled to the face of the bell with cement, seven strands of dry yarn were calked in with hand calking irons and driven back by a sledge hammer. This resulted in the excess water being taken up by the yarn and the cement packed in the joint to its maximum density. The portland cement averaged a tensile strength of 292 lb. and 405 lb. at 7 and 28 days respectively.

After the joint was faced with cement it was covered with wet bags which were kept moistened as long as the joint was exposed to the weather. The cement was allowed to set for at least 24 hours before testing the joint. The line was tested in three sections with air at a pressure of 12 lb. per square inch. The gage showed tight, but each joint was then separately tested with soap suds and not the slightest pin-hole leak was discovered. It is believed that this line will remain permanently bottle-tight.

The time actually required with two men to calk each joint was 45 minutes. But their work was more than simply calking the joint. There were live gas connections to be made, holes to be tapped and assistance given in placing the pipes. As a matter of fact the cost of calkers and cement mixer on this job amounted to 30c. per foot, or the total cost of laying and calking, including the cost of live gas connections, was 48c. per foot.

The gang for laying this main was organized on the job. Labor was paid 40c. an hour and was very scarce at this price. The men were mainly miners and railroad men out on strike, together with a sprinkling of farmers, but the miners and railroad men could not stand the strain of working in the sun and most of these men quit after working from two to six days.



JOINTS FOR CAST-IRON GAS MAINS
A; standard bell. B; bell for cement and combination joints.

In excavation, the top 18-in. of the trench was macadam with a very heavy telford base and in places an additional old paving was encountered. Below this was hard dry clay, which expanded 33 per cent in bulk when loosened. Owing to the proximity of double street-car tracks much additional handling of earth was required. The item of digging bell holes was unusually large and amounted to approximately 1.7 cu.yd. per joint. The trench was 6.5 ft. deep and its average width in clay was 3.1 ft. Including the paving, bell holes and connections the total amount of excavation was 946 cu. yd.

With hand labor for work of this kind we can usually estimate an average of 1 cu.yd. per lineal foot of trench, and the total labor cost per foot is equal to one day's pay for a laborer. On this basis the estimate for all labor would be $3.60 per lineal foot of completed work. The actual cost on this job was as follows:

	Total	Per Foot
Excavation, including removal of paving, digging trench, bell holes and excavations for connections and obstructions	$1,283.70	$1.28
Laying pipe, including calking, connections and testing	480.84	0.48
Backfilling, including repaving, hauling dirt to dump and cleaning up	731.66	0.73
Miscellaneous, including construction of valve manhole, bracing, foremen and city inspection	588.24	0.59
Total	$3,084.44	$3.08
Supervision and engineering		0.31
Grand total		$3.39

Where excavating and backfilling machinery can be used the costs can be lowered. Conditions are not always favorable for their use but the high price of

labor will gradually force the greater use of these mechanical agencies. It is interesting to note that the cost of laying, backfilling and cleaning up amounted to nearly as much as the cost of excavation. Tamping in 6-in. layers is very expensive work.

As an experiment, several joints were made by adding 10 per cent of iron filings and sal-ammoniac to the cement. This was done at the suggestion of C. Winter, of Robert W. Hunt & Co., who conducted the cement tests. These joints also proved to be tight. A few lengths of pipe with standard bell were used, with lead joints calked by hand calking tools driven with sledge hammers.

Where lead joints are properly made they will give much better results than they are usually given credit for. Many such joints have been condemned when probably the true cause was not due to the calking material used. For this reason, special attention was given to the laying of this main in order to ensure that the pipe was laid in the best possible manner and that all causes which might result in a joint leaking were elminated as far as possible.

With reference to the shovels used for excavation, a number of different designs were used and it was interesting to note that a properly designed shovel would give 20 per cent greater efficiency over many shovels in common use. With labor paid at the rate of $3.60 for nine hours work, this increase in efficiency means 72c. per day per shovel. The importance of using a properly designed shovel is not generally appreciated, but with proper tools a man can not only do more work per day but can do it with less fatigue. This human factor should not be overlooked by the engineer or contractor.

British Road Direction Posts and Warning Signs

ALL-METAL road signs have been made standard in Great Britain. In order to evolve signs which might be generally acceptable, the Minister of Transport requested the County Surveyors' Society to report on the question. The proposals made were then submitted to the more important associations of road users and motor organizations, and were finally accepted at a meeting of the Roads Advisory Committee. The accompanying illustrations show the direction and the place and name signs.

The instructions of the Minister of Transport are that the posts should occupy a dominant position and that in certain cases it may be advisable to re-site existing posts to attain this end. Direction arms, it is stated, should be set at such angles as to ensure that each arm lies along the immediate general direction of the road which it indicates. Other suggestions are:

1. The projection of the direction arms over the roadway should be avoided.

2. In all cases the lower arms should indicate the more important road, and only the arms indicating the same road should be set in the same horizontal plane.

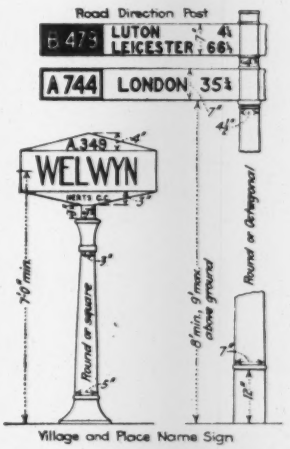
3. Where the text and size of lettering upon the arms of an existing post are otherwise suitable, the route number may be conveniently secured to the end of the direction arm by means of a sleeve connector and set screws.

4. An indication shall be given on the post of the Highway Authority responsible for its maintenance.

5. In all but exceptional cases the arm should be lettered on *both sides*, the nearest village being given first, then the nearest important town, followed by the terminal town where necessary. The mileage should be given in figures only, immediately following the place to which it refers, the lowest fraction being a quarter.

6. Wherever possible, the direction post should be placed in such a position as to be visible to traffic from all converging roads for a distance of at least a hundred yards.

For warning signs and notices, the Ministry recommends on top of a 9-ft. post, a red triangular "danger" sign. The special danger to be avoided is indicated by a symbol, together with a clear and simple title in letters 2 in. high, upon a vertical plate 12 in. wide and 21 in. long fastened to the post below the red triangle. The list of dangers is: "School," "Level crossing," "Cross-roads," "Corner," "Double Corner," "Steep Hill." Cast-iron plates are recommended with letters and details in relief. Flat enamelled sheet iron is liable to damage and defacement by stones. In towns and suburban areas, where street lighting arrangements permit, the illumination of road signs is desirable. At special danger points the red triangle, together with the appropriate symbol should be enlarged to 1½ times the standard size, and lighted.



TYPES OF ALL-METAL ROAD SIGNS IN GREAT BRITAIN

The Ministry recommends that the color of the supporting posts and the field of the sign should be plain white; the color used to denote the name of the highway authority on the sign being optional.

Hard-Surface Roads Should Be at Least 18 Feet Wide

A minimum width of 18 ft. for hard-surface roads is recommended by the U. S. Bureau of Public Roads. The maximum width of truck body generally permitted is 8 ft. and 5½ ft. is the ordinary clearance width of automodrive with the wheels closer than 1½ ft. to the edge biles. At an average speed of 30 miles an hour it is of the pavement, says the bureau. For trucks at an unreasonable to expect the driver of an automobile to average speed of 15 miles an hour, this distance should not be less than 1¾ ft. on account of the great width of the rear wheel. Three feet seems to be a minimum safe clearance between bodies. Inasmuch as a certain amount of truck traffic is to be expected on all main country roads, the minimum width of surface should be 18 ft. to provide these clearances when an automobile meets a truck.

Where the frequency with which trucks pass each other becomes a big factor, as in the neighborhood of large cities, the minimum width of pavement should be 20 ft. to provide a clearance of 3½ ft. and a safe distance of wheels from edge of pavement.

Drainage Ditches for Rio Grande Irrigation Project

Reclamation of Lands Spoiled by Seepage and Alkali from Excess Irrigation—Cost of Contract and Force Work

By L. M. Lawson
Project Manager, U. S. Reclamation Service, El Paso, Tex.

EXTENSIVE land drainage works to carry off seepage water which threatened to render useless a large area of irrigated land by waterlogging and alkali accumulation have been carried out with satisfactory results on the Rio Grande irrigation project of the U. S. Reclamation Service. Plans for this drainage work were described in *Engineering News-Record* of Sept. 18, 1919, p. 543. The present article relates to the results obtained.

Stated briefly, 70 per cent of this project, comprising a gross area of 200,000 acres located in New Mexico, Texas and Mexico, was seeped or in danger of becoming waterlogged in 1917. The cause of this condition was the over-application of irrigation water to

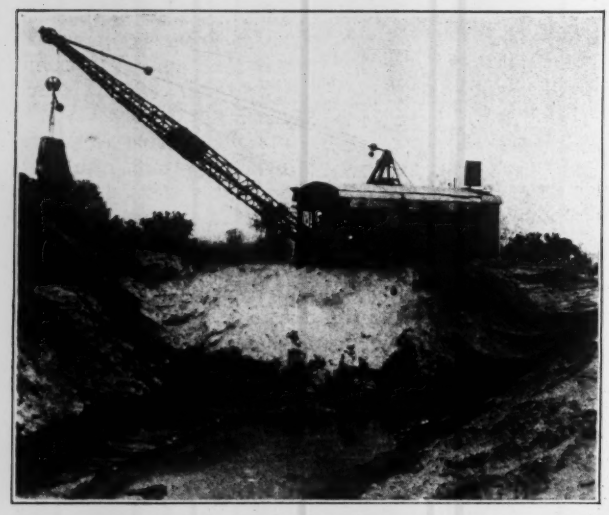


FIG. 1. EXCAVATING DRAINAGE DITCH ON RIO GRANDE IRRIGATION PROJECT

lands of the long narrow valley after completion of the Elephant Butte storage dam. Before storage was available the normal flow of the Rio Grande was so erratic and intermittent that long dry periods were experienced and the necessity for drainage was not so apparent. With improvement in irrigation facilities and large available water supply the rise of the ground water was accelerated and for a time the entire irrigated area was threatened with destruction through seepage.

Plans for relief, made in 1917 by a board of engineers, covered the construction of approximately 346 miles of open drains involving the excavation of approximately 17,700,000 cu.yd. By Jan. 1, 1922, about 222 miles or 70 per cent of the entire system had been constructed. Records of seeped and drained areas show that 64 per cent of the total area is now drained and protected, compared with 70 per cent seeped before the construction of drains had been undertaken.

Construction work on a drainage ditch by a dragline excavator is shown in Fig. 1, and Fig. 2 shows a lateral irrigation flume over a ditch. Fig. 3 shows the construction of a double-barrel concrete pipe culvert which is typical of road and canal crossings of the ditches.

Government forces built 206 miles of these drainage ditches, requiring 10,421,708 cu.yd.; 15.7 miles, with

FIG. 2. FLUME CARRYING IRRIGATION LATERAL OVER DRAINAGE DITCH

850,341 cu.yd., were built by contract. The total and unit costs of excavation were as follows:

	Total Cost	Unit Cost—Per Mile	Unit Cost—Per Cu.Yd.
Government	$890,220	$4,321	8.55c.
Contract	99,031	6,307	11.69c.

A number of interesting features are presented by this work, in addition to the cost and the mechanical means of accomplishment. The valleys of the Rio Grande below Elephant Butte dam and within the limits of the Rio Grande irrigation project, are composed largely of sand accumulations from side arroyos or washes. The fine silt from the upper river has generally formed laminations with these sand deposits in relatively thin layers. Practically all ditches are excavated through the upper silt and reach into the sand strata where underground water movement is facilitated.

The first drainage construction was accomplished in irrigated areas where a high water table was yearly

FIG. 3. CULVERT CARRYING DRAINAGE UNDER ROADS AND IRRIGATION CANALS

reducing the crop yield. The first discharges of drains were necessarily high, but later were reduced to flows affected largely by the time and amount of irrigation. Drains located near the river, which is in reality the main canal of the project, have an average discharge of 2.25 sec.-ft. per lineal mile. Those located near the foot-hills or mesa, which receive their flow from irrigation supply, average a discharge of 1 sec.-ft. per lineal mile. The drains first excavated in seeped and waterlogged areas reach a maximum discharge very rapidly.

During the period of high-water table, previous to the construction of deep channel outlets, a large area of project land was subject to accumulations of alkali because of evaporation and capillary action. The salt content of the Rio Grande water at Elephant Butte reservoir is approximately 40 parts in 100,000. The average in drainage canals is 191 parts, with a minimum of 80 and a maximum of 435. These canals discharge into the river at various points throughout the project length. A reasonable minimum of salt content in the irrigation supply for the lower lands is

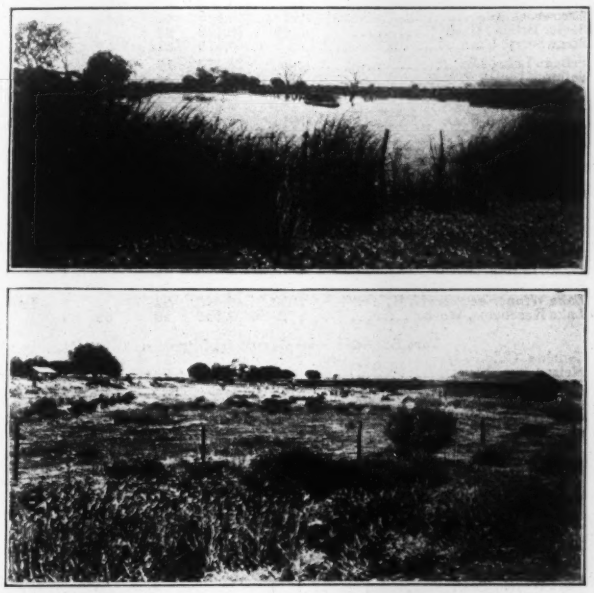


FIG. 4—EFFECT OF DRAINAGE OF IRRIGATED LAND
Above; accumulation of seepage water. Below; results of drainage, two years later.

maintained by dilution with river supply direct from the dam.

At the Leasburg diversion dam, 60 miles below Elephant Butte dam, the salt content of the Rio Grande irrigation supply averages 45 parts in 100,000. At the Mesilla dam, 80 miles below Elephant Butte, 55 parts. As the International diversion dam, 120 miles below Elephant Butte, the average is 70 parts. During the period of non-irrigation when no flow is released from Elephant Butte dam, and the water at El Paso is composed entirely of discharge from drains or seepage, the salt content is 140 parts per 100,000.

A characteristic of the Rio Grande before storage was accomplished was the rapid increase in salt content as the flow diminished. This alkaline condition was so severe at times of normal low-water flow that the use of river water for boiler or irrigation purposes was prohibitive. As the river flow increased with the spring floods from melting snows in the upper drainage area of the river, the percentage of salt content was decreased. Drainage canals show the opposite condition, an increase in discharge registering an increase in salt content. Based on the analysis of discharge of drainage canals, over 500,000 tons of alkali have been removed from the project lands. Analysis of the drainage water shows the drain discharge to contain over 1,000 tons of alkali in solution in 24 hours.

Although the drainage ditches lower the water table and largely remove the opportunity for further accumulations of alkali by holding the water table sufficiently below the line of action of capillary attraction, they do not accomplish the removal of the salt accumulations without individual reclamation work on the part of the landowners. The deep main drains furnish an outlet for underground water accumulations, but deep plowing and flooding of alkali land are required to remove salt accumulations. Inducement to the property owners to perform such work is offered by delivering water for flooding purposes at a very nominal rate.

Considerable success has been obtained in these leaching processes, and some areas which were so highly impregnated with salt as to be incapacitated from producing crop yields have within short periods been reclaimed and made productive. With further use of this practice the remaining salt areas will regain their original fertility. The salt content of the drainage discharge will then be reduced to such a minimum as to make this water available for irrigation without the dilution now necessary.

New Refuse Destructor at Rochdale, England

Mixed refuse, screened to remove "fine dust," is incinerated in a new destructor at Rochdale, England, and the resulting heat is used to produce power for all works' purposes, driving the refuse elevators, the screens, the ash and clinker aërial tramway, and also the electric light plant for the entire installation. The destructor is a four-cell, top-feed, continuous-fire Heenan & Froude unit, with a capacity of 450 long or 500 short tons per week of six working days, or some 80 short tons a day. The gases of combustion pass through a Babcock & Wilcox boiler with 2,197 sq.ft. heating surface, which supplies steam under 140 lb. pressure to a 100-kw. turbo alternator. On arriving at the works, the "dry ashbin refuse," as the London *Surveyor* styles it, is "tipped" into specially constructed covered hoppers from which bucket elevators lift the refuse to the "vibratory screens." The screenings are discharged into covered hoppers and the remainder of the refuse onto destructor charging floor. The "fine dust" from the screens and the clinker (and ash?) from the destructors are moved by "an aërial ropeway" to a dump at the rear of the destructor. The "ropeway" displaces a 9,900-lb. motor truck and two horses and carts formerly used for moving this material. The cost of the plant described, *The Surveyor* states, will be under the £19,500 loan ($95,000 at normal exchange) authorized for the purpose. The scheme was carried out by J. Ardern, cleansing superintendent of Rochdale.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Largest Storage Reservoirs in United States

Sir—There was published in *Engineering News-Record* on May 11, 1922, p. 799, a table of the larger reservoirs in the United States in the year 1920, compiled by me for the Committee on Water Supply of Engineering Council. Since then we have been indebted to numerous correspondents for additions and corrections. These have been embodied in the accompanying abbreviation and extension of the original table, which is divided into four parts. Part A includes all of the 38 reservoirs holding over 50 billion gallons each. Corrections to the rest of the table (which is not reprinted)

TABLE II—RESERVOIRS FOR WATER SUPPLY COMPARED WITH ALL RESERVOIRS LISTED

Size Billion Gallons	All — Number	All — Capacity Billion Gallons	Water Supply — Number	Water Supply — Capacity Billion Gallons	Per Cent of Total — Number	Per Cent of Total — Capacity
Over 400	2	1,288	0	0	0	0
Over 200	6	2,498	0	0	...	...
Over 100	13	3.501	1	132	...	...
Over 50	38	5,252	2	195	5.25	3.73
Over 20	75	6,307	7	348	9.35	5.50
Over 10	122	6,982	14	441	11.45	6.32
Over 4	208	7,831	30	544	14.50	7.95

are shown in Parts B and C of the revised table. These contain data for additional reservoirs now reported, and corrected data where there are important changes. It also shows revised figures for capacities of two reservoirs, one of which is reported to be much reduced in capacity by silting and the other not capable of being filled to its flow line because of the condition of the dam.

It is of interest to note that of 208 reservoirs in the revised

TABLE III—SUMMARY OF ALL 208 RESERVOIRS BY SIZE

Reservoirs Between Stated Limits, Billion Gallons	Number of Reservoirs Reported of this Size	Combined Capacity of Reservoirs of This Class Billions Gallons
Over 400	2	1,288
200 to 400	4	1,210
100 to 200	7	1,003
50 to 100	25	1,751
20 to 50	37	1,055
10 to 20	47	675
4 to 10	76	849

table with capacities of 4 billion gallons and over, and with an aggregate capacity of 7,831 billion gallons, 30 reservoirs holding 544 billions are used for public water supply. (See Part D of Table I for detailed list, and Table II for comparative summary. For another summary covering all 208 reservoirs, see Table III.) In number the public water-supply reservoirs are about one-seventh of the total, but they represent only 8 per cent of the aggregate capacity. No doubt the average cost per unit of capacity of the reservoirs used for municipal supply has been much greater than the reservoirs built for power and irrigation and the total investment in reservoirs of this class is therefore greater than would be indicated by these figures.

New York City, Sept. 24. ALLEN HAZEN.

[Note: The information below refers to tabular matter herein, particularly to Table I in the column opposite.—EDITOR.]

Capacities include only the available capacity ordinarily and easily used and do not include water below the outlet and not available; nor water held above the flow-line by flash-boards unless the flash-boards are a part of the regular equipment and are normally used each year; nor temporary storage at times of high flood.

The information was first secured and verified by a well informed hydraulic engineer in each state selected for this purpose by the council. Figures for several states from which returns were not received have been supplied from any other source believed by the committee to be trustworthy.

As Engineering Council was abolished the work of this committee was terminated while it was still in an incomplete state, and this table represents this particular work as far as it had been carried.

The second edition differs from the first by embodying all the additions and corrections received since the table was first published.

TABLE I—LARGEST STORAGE RESERVOIRS IN THE UNITED STATES IN 1920

(Second Edition, Revised to Sept. 9, 1922. First Edition Published in *Engineering News-Record*, May 11, 1922.)

Name of Reservoir	Year Reservoir Began to Fill	Area, Acres	Cap., Billion Gal.	Depth of Water, Ft. Max.	Depth of Water, Ft. Aver	Used for
Part A: 38 Reservoirs in Excess of 50 Billion Gallons Capacity						
Elephant Butte, N. M.	1915	40,080	863	193	66	Irr.
Roosevelt, Ariz.	1908	16,832	425	225	78	Irr.
Pathfinder, Wyo.	1909	22,700	349	184	47	Irr.
L. Winnibagoshish, Minn.	1884	103,040	338	...	10	Nav.
Jackson Lake, Wyo.	1916	25,530	276	41	33	Irr.
Leech Lake, Minn.	1884	149,760	247	...	5	Nav.
Moosehead Lake, Me.		74,900	177	...	7.3	Pow.
Ripogenus, Me.	1916	28,800	157	...	22	Pow.
Clear L. Klamath, Cal.		25,000	150	24	18	Irr.
Shoshone, Wyo.	1909	6,604	149	233	69	Irr.
Ashokan, N. Y.	1913	8,180	132	190	50	W. S.
Twin Lakes, Me.			123	...	...	Pow.
Hebgen, Mont.	1915	13,000	115	81	29	Pow.
Medina, Tex.	1913		98	156	...	Irr.
Big Meadows, Cal.		15,500	96	...	20	Pow.
Bridgewater, N. C.	1919	6,510	94	...	44	Pow.
Lahontan, Nev.	1914	12,000	94	112	24	Irr.
Arrowrock, Ida.	1915	2,860	91	247	98	Irr.
Sevier Bridge, Utah	1908	10,120	82	...	26	Irr.
Strawberry, Utah		8,370	81	61	30	Irr.
Sebago Lake, Me.		28,672	77	...	8.2	Pow.
Salmon, Ida.	1911	3,500	74	120	65	Irr.
Azicohos, Me.	1913		71	60	...	Pow.
Lake Kachess, Wash.		4,800	68	53	44	Irr.
Belle Fourche, S. D.	1910	8,010	66	100	25	Irr.
Magic, Ida.	1911	3,800	65	...	52.5	Irr.
Moosolookmaguntic L., Me.		16,608	64	...	11.9	Pow.
Spednic Lake, Me.		14,618	64	...	13.5	Pow.
Wachusett, Mass.	1905	4,200	63	150	46	W. S.
Sawyer Lake, Me.		6,720	60	...	27.3	Pow.
Deer Flat, Ida.	1908	9,835	58	58	18	Irr.
Salmon River, Ida.	1911	3,500	58	...	53	Irr.
Pine River, Minn.	1886	562	58	...	3	Nav.
Blewett Falls, N. C.	1912	2,500	57	...	74	Pow.
Warm Spring, Ore.	1919	4,200	55	...	43	...
Buenavista Lake, Cal.	1890	25,000	55	15	7	...
Lake Winnepisaukee, N. H.	1850	45,400	52	...	4	Pow.
Lake Keechelus, Wash.		2,550	50	66	60	...
Part B: Additional Reservoirs Reported						
Sanchez, Colo.			34	...	...	Irr.
Nelson Res., Mont.		4,560	22	53	19	Irr.
Holter, Mont.	1918		20	100	..	Pow.
Lower Otay, Cal.	1919		19	...	...	W.S.
Hauser Lake, Mont.	1911		15	65	..	Pow.
Canyon Ferry, Mont.	1898	4,750	13	39	9	Pow.
Madison Lake, Mont.	1906	4,250	12	44	9	Pow.
Part C: Revised List of Reservoirs where important changes in data are reported.						
Sherburn Lake, Mont.		1,735	22	69	38	Irr.
East Park, Cal.	1911	1,850	17	88	28	Irr.
Lake McMillan, N. M.	1893	7,860	15	25	6	...
Stanley Lake, Colo.	1910		16	108	...	Irr.
Cold Spring, Ore.	1908	1,500	16	90	33	Irr.
Bumping Lake, Wash.		1,350	11	36	25	...
Fort Worth, Tex.	1914	...	8	36	...	W.S.
Lake Clealum, Wash.		2,260	6.8	11	9	...
Willow Creek, Mont.		1,050	5.4	65	16	Irr.
Conconully, Wash.	1909	460	4.7	55	31	Irr.
Part D: Reservoirs Used For Water Supply						
Ashokan, N. Y.	1913	8,180	132	190	50	W.S.
Wachusett, Mass.	1905	4,200	63	150	46	W.S.
Croton, N. Y.	1906	3,360	45	157	41	W.S.
Kensico, N. Y.	1916	2,218	38	155	52	W.S.
Cheesman, Col.	1901	874	26	222	68	W.S.
Crystal Springs, Cal.	1888	1,500	23	...	48	W.S.
Haiwee, Cal.	1911	2,100	21	60	30	W.S.
Lower Otay, Cal.	1919		19	...	...	...
Croton Falls, N. Y.	1910	1,600	15	100	29	W.S.
Morena, Cal.	1911	1,370	15	142	34	W.S.
Tomhannock, N. Y.	...	...	12	...	...	W.S.
Johnstown, Pa.	1911	900	12	80	42	W.S.
Carmel, N. Y.	1895	998	10	55	31	W.S.
Cross River	1908	850	10	106	36	W.S.
Nepaug, Conn.	1916	851	9.560	97	33	W.S.
Boonton, N. J.	1904	900	8.600	100	25	W.S.
Decatur Dam, Ill.	1920	3,500	8.000	...	7	W.S.
Fort Worth, Tex.	1914	...	8.00	36	...	W.S.
Sudbury, Mass.	1896	1,220	7.900	...	21	W.S.
Amawalk, N. Y.	1897	600	7.680	...	20	W.S.
San Fernando, Cal.	1914	410	7.500	...	56	W.S.
Titicus, N. Y.	1894	707	7.167	105	31	W.S.
San Andreas, Cal.	1874	549	6.500	90	36	W.S.
Pueblo, Col.	1908	818	6.000	30	22	W.S.
Sodom, N. Y.	1890	575	4.883	72	26	W.S.
Hemlock, Conn.	1913	500	4.500	80	28	W.S.
San Leandro, Cal.	1875	335	4.323	100	40	W.S.
Calaveras, Cal.	1918	...	4.200	...	...	...
Bog Brook, N. Y.	1890	410	4.145	54	31	W.S.
Middle Branch, N. Y.	1878	432	4.000	...	54	W.S.

Asphyxiation by Gas in a Sewer Manhole

Sir—At the convention of the American Society of Sanitary Engineers held last month near Sandusky, Ohio, mention was made of a case of asphyxiation due to gas collected in a sewer manhole. Inquiry by the writer brought out the following facts: The accident (in Jacksonville, Fla.) occurred to two plumbers working in a manhole on a 12-in. intercepting sewer on a separate system. The sewer is over a mile long, delivering into a pump chamber, with an inverted siphon upstream from the pumps.

The city workmen have found that the manholes on the lower portion of the sewer all collect a gas which is non-inflammable, odorless and evidently heavier than air. The gas also collects in the storm-water drains and a contractor's laborer who entered one of these manholes was overcome and confined to a hospital for several weeks.

Before entering a manhole the test is now made with a lantern and at no time has any combustible gas been found in these manholes.

My information has been received from John Fowler, building inspector at Jacksonville.

Although this appears to be an unusual case, recording it in your columns may be the means of saving lives.

New York City. R. A. MacGregor.
Office of Commissioner of Public Works, Borough of Manhattan.

The Effect of Alkali on Concrete

Sir—Much literature has been published upon this subject, ending with an article in *Engineering News-Record*, July 13, 1922, on the disintegration of brickwork and concrete in Glenn County, in California.

The writer's responsibility for the construction of the cantonment for the garrison at Basrah in Mesopotamia has caused him to apply the results of previous experience to eliminate this trouble.

The soil here is similarly alkaline to that described by the writer of the above-named article, except that the predominating salt is calcium sulphate.

The crux of the whole question seems to be whether or not capillarity, followed by evaporation of the ground water, can take place in the structure.

Few investigations can be traced, which have been published, as to this phase of the problem, since Richard L. Humphrey stated, in a discussion before the American Society of Civil Engineers (Vol. LXXII, 1910, page 599) "Generally it" (i. e. disintegration) "is found where the brick or stone is quite porous, and has a high absorption. In such cases the disintegration occurs at the ground line, or at that point above it which marks the limit of capillarity action, where the water evaporates."

This confirms the writer's observations that where the damp-proof course, in an ordinary building, is efficient, it not only prevents damage above itself but is equally effective in preventing deterioration below ground, especially if the coating can be made to extend down the sides of the foundation, to such a depth below the actual ground surface that evaporation cannot take place.

The action appears to be that the alkaline ground waters rise by capillarity into the foundations and walls, until at some level (generally about two feet above the ground, in this hot dry climate) all the moisture has been evaporated, and the salts left behind. This process is, of course, continuous and cumulative.

If the water is prevented from rising, there will be no concentration of salts, increasing year after year, destroying the building.

It will probably be found that in the cases illustrated in the article in your July 13 number, there is no effective damp-proof course in the walls, or behind the concrete abutment (placed before the back-filling was commenced).

Local experience is, that if all movement of ground water into, and subsequently out of, the structure is prevented, the trouble is reduced to negligible proportions, and that the water-proofing of all surfaces exposed to evaporation is of greater importance than an improvement in the concrete or brickwork itself.

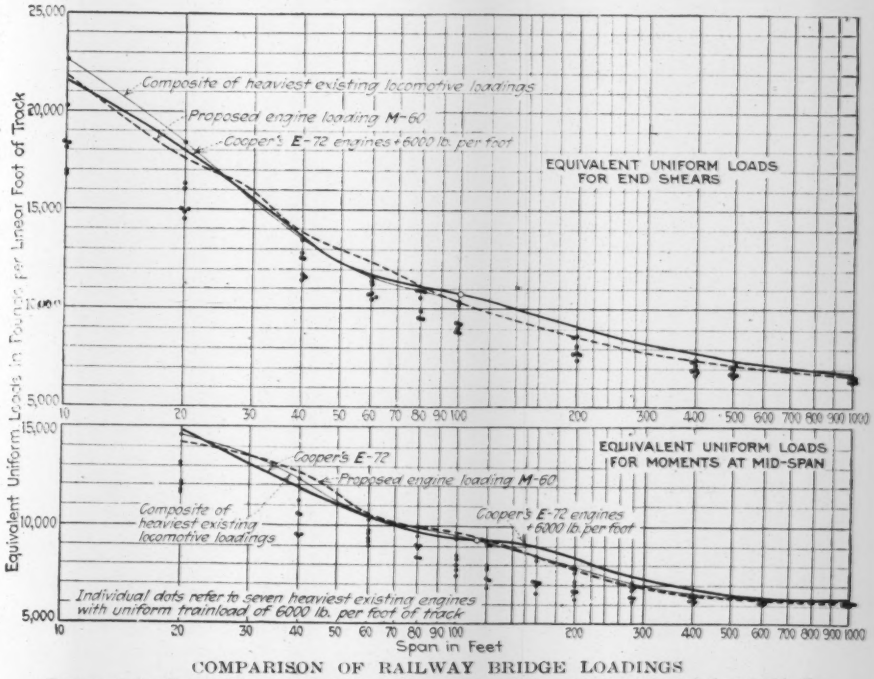
H. C. Lott,
Deputy Director of the R. E. Services.

Basrah, Mesopotamia, Aug. 28.

Cooper's Loading Fitted to Modern Railway Bridge Traffic

Sir—I have read with great interest your editorial "Bridge Loading," in the Sept. 14 issue, page 421.

I cannot agree with your view that the Cooper loading is no longer safe to use without arbitrary adjustments for each individual case. If properly applied with unbiased judgment, the Cooper loading can be brought into harmony with actual modern loads as well as any other loading. This may be appreciated at once by an examination of the attached diagram, which is self-explanatory. The entire question is not as complex as it would appear. The apparent complexity lies in the variety of actual engines and in the fact that engine weights have grown faster than car weights.


Composite of heaviest existing locomotive loadings
Proposed engine loading M-60
Cooper's E-72 engines +6000 lb. per foot
EQUIVALENT UNIFORM LOADS FOR END SHEARS
Equivalent Uniform Loads in Pounds per Linear Foot of Track
25,000
20,000
15,000
5,000
10 20 30 40 50 60 70 80 90 100 200 300 400 500 600 700 800 900 1000
Cooper's E-72
Proposed engine loading M-60
Composite of heaviest existing locomotive loadings
Cooper's E-72 engines +6000 lb per foot
EQUIVALENT UNIFORM LOADS FOR MOMENTS AT MID-SPAN
Individual dots refer to seven heaviest existing engines with uniform trainload of 6000 lb. per foot of track
15,000
10,000
5,000
Span in Feet

COMPARISON OF RAILWAY BRIDGE LOADINGS
Proposed loading M60; modified Cooper loading (E72 engines followed by 6,000 lb. per ft.); seven heaviest existing engines followed by 6,000 lb. per ft.

Cooper's loading is sufficiently elastic to be adjustable to the change in both of these elements.

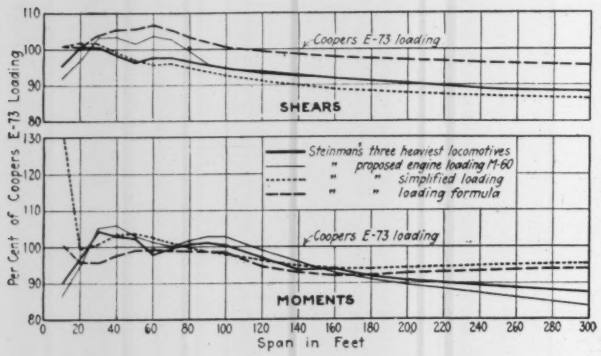
New York, Sept. 15. O. H. Ammann,
Hudson River Bridge Corp.

Cooper's Loading Is Adequate

Sir—There are at least two sides or viewpoints to every question. *Engineering News-Record* has published two editorials and one article rather highly commending the loading proposed by Steinman. Definite statement has been made that the Cooper system is outgrown, that it is deficient, and that a new system is necessary. It would seem rather hasty action has been taken. It is doubtful whether, in fact, there are two sides to the question of loading to be used in the design of railway bridges. The entire discussion centers around an accurate mathematical comparison of existing engines with design loads.

Steinman has taken existing heavy locomotives and prepared a diagram showing the composite of the maximum effect of these locomotives on bridge structures. Steinman's proposed loading is in the form of a Mallet engine, made to produce the same effect on bridge structures as the composite effect of existing locomotives. Undoubtedly Cooper did the same thing, when he proposed his loading system in 1894. His engine is of the Consolidation type; however, it is to be noted that Cooper's engine is double-headed, whereas Steinman's is not.

The fact that any bridge structure examined for a particular engine does not give uniform stresses means nothing. The same thing will happen whether Steinman's or Cooper's loading is used as the basis. These loadings are nothing but a composite of existing loads. In this connection it is to be noted that what may be called the peak point, that is, the maximum effect of an engine on a bridge structure, occurs at different span lengths. The maximum effect for the Atlantic engine is on short spans, the maximum effect for the Pacific, Consolidation, Mikado, Santa Fé



COOPER AND STEINMAN LOADINGS COMPARED

and Mallet engines is on successively longer spans. Therefore, when bridges are designed for a loading like Cooper's, which gives the composite effect for existing engines, and later compared for an actual engine, there will be a wide variation in stresses. This is true whether the design loading used is Cooper's, Steinman's or any other loading based on the composite of actual engines, and is nothing but what is to be expected.

The Cooper loading provides for an equality between the effect of the hauling engine and the following train load. This equality is not maintained in the Steinman loading, apparently for the reason that Steinman chooses to assume that a following train load of 6,000 lb. per foot of track is the maximum. Such is not the case. Maximum locomotives have been selected, but not maximum cars. Actual cars now in operation have an average weight considerably in excess of 8,000 lb. per lineal foot of track.

For some unknown reason, Steinman's principal loading is designated "M 60." It may be in order to compare it to E 60. But the M 60 is not comparable to the E 60 loading; it is, in a sense, however, comparable to E 73.

Referring to the original statement that this entire matter is simply an accurate presentation of actual facts, if the same maximum actual engines used by Steinman are selected, then it is a fact that the Cooper E 73 loading represents the composite effect of the actual engines more nearly than Steinman's M 60, both for shears and moments, as shown by the adjoining diagram.

Steinman's paper, therefore, seems to prove that the Cooper system of loading is entirely satisfactory, and is to be retained, particularly as it is shown that the proposed loading does not more nearly represent actual loads than the Cooper loading. Further, the Cooper system is used as a measure for rating existing bridges; existing records cannot be changed, from the standpoint of either money value or time, to the new yardstick. Certainly, the proposition to use one system of loading in design and another in rating is untenable, as this would mean that all new structures must be calculated for two systems of loads.

In conclusion, so far as the safety of traffic is concerned, a span is a span, whether long or short; long-span bridges are few in number, and the vast majority of existing spans are less than 120 ft. in length.

P. G. LANG, JR.
Engineer of Bridges, Baltimore & Ohio R. R.

Baltimore, Sept. 18.

To Mix Good Concrete

Sir—Having followed the development of concrete for a number of years, I have been surprised by the slowness of improvement in specifications and methods of mixing. Recently revised reference books recognize the theory of a good mixture, and tell what to get, but give nothing new as to how to get it.

For a long time it was puzzling to see the wide discrepancy between the strength of the units and the safe loading strength of the finished product. Microscopic tests seemed to throw some light on this matter, showing voids and unhydrated cement as a reason for loss of efficiency. Perfect concrete can be made in the laboratory, in small quantities. Perfect concrete should be waterproof and have the density and strength of the aggregate. Laboratory methods cannot prevail in the field, however, and I evolved a theory to get a better mixture with available plant and methods.

Water being hard, it must be broken either with heat or friction. Dough mixed by unskilled hands is apt to be lumpy. The skillful housewife mixes hers rather thin, and then works in additional flour, kneading it with her hands, until the right consistency is reached. The same principle applies to mixing concrete, if the material is proportioned right, with an excess of sand and cement, rather than a deficiency, and will cost no more on an average than prevailing methods.

The theory has been tested on two jobs, with the consent of contractor and architect, and met approval in each case. One was foundations, basement walls, floor slabs and beams and columns in a court house in South Dakota. The water was strongly alkaline with some magnesia, and a small percentage of cement was added to partly offset these. Tests covering a period of six months after completion showed concrete of unusual density and strength, with no cracks or voids visible. The architect, who has built state capitols and court houses as well as business blocks, stated that it was the best concrete he had seen. The second job was a storeroom and loading platform in St. Paul, Minn. Although the gravel was rather poor, results were good here, as was proved when we had to cut through the walls for some changes in the plumbing plans.

The method is: Place sand, cement and water for full batch in mixer, in the order named. Mix as for grout. Then place the coarse aggregate in mixer, which will knead lumps out in getting to the bottom, and also coat each particle with the grout. Have water to 70 deg. F. or warmer, or mix longer.

Turn until thoroughly mixed.

On the jobs above mentioned the time in the mixer has been approximately the same as for the usual method of turning dry and then introducing water, and the results have seemed better, but might be better still with longer turning.

BUTLER SMITH.

Superior, Wis., Sept. 1.

NEWS OF THE WEEK

New York, October 5, 1922

New Traffic Survey Starts in Connecticut

State and Federal Government Join in Most Comprehensive Program Ever Attempted

Washington Correspondence

Under a co-operative agreement the U. S. Bureau of Public Roads and the Connecticut State Highway Department have undertaken the most comprehensive survey of highway traffic ever attempted, supplementing last year's survey. The survey is of an intensive character and will continue for a period of 12 months so that the seasonal variations in traffic may be studied and recorded. The principal purposes of the survey are as follows:

To determine the total traffic density, type of traffic, and seasonal, daily and hourly variations; gross truckloads, net commodity loads and overloads; the net tonnage movement and character of freight by motor-truck, and average length of haul of motor-truck shipments, with regard to commodities, capacities, and production areas; and the relation of motor transport to other methods of transportation.

Data are sought which will make possible a more intelligent allocation of construction and maintenance funds.

Dr. J. Gordon McKay has resigned as a member of the faculty of the University of Wisconsin to undertake this work. A similar survey is to be made in California. Another will be made in a typical agricultural state, another in a state where both agriculture and manufacturing are highly developed, and another in a southern state.

Stone Producers Deny Guilt

Attorneys for the Bedford stone organizations in Indiana and affiliated companies and individuals in Indianapolis, Bedford and the stone producing district of the state, named as defendants in an anti-trust injunction suit brought by U. S. Lesh, Attorney General of Indiana, in the Superior Court in Indianapolis March 24, have filed a general answer denying guilt. Judge Moll of the Superior Court overruled on Sept. 5 demurrers filed in the case and ordered the defendants to submit answers. The answer averred that the defendants had not committed any acts in violation of the law or in restraint of trade or commerce.

Sues City for Engineer's Death

Suit for $15,000 has been brought against the city of Phoenix, Ariz., by the administrator of the estate of Hiram Phillips, the consulting engineer of St. Louis, Mo., who was killed Dec. 22, 1921, when the automobile in which he was making an inspection trip was overturned. At the time Mr. Phillips was inspecting the Verde river water-supply system for Phoenix.

Operators and Miners Seek Plan to Fix Coal Wages

Unable to agree among themselves as to a plan for negotiating future wage scales, the bituminous coal operators have entered the conferences with the miners' union as individuals. The mine workers, on the other hand, have announced through John Lewis, president of the United Mine Workers, that they are in unanimous agreement and insist that the operators form a responsible organization with which they can deal.

The miners are hostile toward the fact-finding commission created by national legislation; but the operators are split, some sharing the workers' views and others inclined to await the findings of the President's commission. The conference is now in session at Cleveland.

Antioch Loses New Move in Water Injunction Suit

The city of Antioch, Cal., has been denied permission to file an amended complaint in its endeavor to obtain a permanent injunction to prevent irrigationists from diverting water from the San Joaquin and Sacramento Rivers. The original suit was won by the city in the Superior Court and the decision was reversed in the Supreme Court. A review of the original case was published in *Engineering News-Record* March 24, 1921, p. 513, and decisions of the State Supreme Court subsequently made were reported in the issues of Oct. 27, 1921, p. 697, and April 13, 1922, p. 627, respectively.

The new petition sought to have additional water users defendants in the action and would have involved practically 6,000 irrigationists of the two streams. In denying the new application Judge A. F. St. Sure of the Alameda County Superior Court held that the issue had already been settled in the decision handed down by the State Supreme Court.

U. S. Public Roads Bureau Plans Rural Engineering Research

In the future the rural engineering division of the U. S. Bureau of Public Roads will concentrate its work on research problems. Heretofore the division has found it difficult to relinquish its wide activities in extension work. The point now has been reached, it is believed, where the states and local agencies are sufficiently acquainted with the work and have the facilities to carry forward the educational part of the program.

Increased research is planned on such problems as the flow of water in drainage ditches; drainage by pumping; the effects of alkali waters on concrete; and the use of concrete pipe in connection with reclamation projects.

Brazil Holds International Engineering Congress

Delegates from Many Lands Celebrate National Centennial and Discuss Technical Developments

The International Congress of Engineering held in Rio de Janeiro, Sept. 17-30 was successful, judged either by the papers presented or by the number of official delegates. Representatives were present from all the principal engineering societies of the United States, Canada, Argentina, Belgium, France, Mexico and other countries. Delegates were there also from each of the states of Brazil and from a large number of private organizations.

Preliminary to the opening session a committee of the Brazilian Engineering Club was received by the American Ambassador Extraordinary, Secretary of State Charles Evans Hughes. This committee expressed its appreciation of the initiative and the work of certain Americans with regard to the congress and the co-operation that had been extended to the commercial attaché to the Brazilian Embassy in Washington, Sr. Sebastiao Sampaio, through which it was possible to hold the meetings in connection with the exposition.

American Engineers Praised

The earlier work of American engineers in Brazil was eulogized, special mention being accorded to Greenough, who, by installing the first electric-traction system in Rio and in South America, was instrumental to a large degree in having similar systems adopted in conservative Europe; to Corthell, former president of the American Society of Civil Engineers, who solved the problems of the shifting sand-bars at the entrance to Rio Grande harbor, and of Pearson, victim of the Lusitania sinking, to whom the inhabitants of Rio and Sao Paulo owe their light and power system.

A point of particular interest to American engineers is the fact that in the Engineering Club of Rio is a hall of fame where are placed the busts of prominent engineers as a token of the esteem in which the engineering profession is held in Brazil. In this hall are the busts of Rodriguez Alves, a former president and of their last emperor, Dom Pedro II, both of whom had displayed unusual interest in matters pertaining to engineering.

The sessions of the congress were opened with an address by Getulio das Neves, president ad interim of the Engineering Club of Rio de Janeiro, who was followed by Calvin W. Rice speaking for the American Society of Mechanical Engineers and other American engineering bodies represented by him. The keynote of the congress was struck in the address by Verne Leroy Havens, editor of *Ingeniería Internacional*, representative

(*Continued on p. 581*)

Demonstrate Better Town Roads at State Fair

Low-Cost Oiled Cinder Section Laid as Demonstration on Midway at Trenton, N. J.

In the attendance of tens of thousands of voters from townships in every county of New Jersey at the Interstate Fair, now being held at Trenton, Thomas J. Wasser, state highway engineer, has seen an opportunity of spreading the doctrine of better township roads. For the first time in its history the state fair, this year, has a good

SIGN AT DEMONSTRATION ROAD

roads exhibit and a demonstration section of low-cost oiled cinder road.

While New Jersey is active in the development of its state highway system under the Federal-Aid Highway Act, one of the greatest needs today is believed to be the improvement of roads in the minor political subdivisions of the state. The purpose of the highway exhibit, therefore, is aimed primarily at residents of the smaller townships, where plain earth roads prevail. The New Jersey State Highway Department is endeavoring to get the townships interested—to the extent of raising adequate funds—in town-road improvements and the type of surfacing advocated consists of a 6-in. thickness of cinders, laid in two layers, and surface-treated with a coal asphalt oil. The type is the same as that described by F. H. Shepherd and E. E. Butterfield, engineers in the Office of the President of the Borough of Queens, New York City, in *Engineering News-Record* of Sept. 22, 1921, p. 477. This type of surfacing can be put down, it

DRILLING CORES FROM PAVEMENT

is estimated, for a 9-ft. width at a cost of $5,300, or for a 16-ft. width, at $9,400 per mile.

Under New Jersey's state-aid legislation the maximum amount of state money which may be allocated for town-road construction in any one county is $25,000. Additional sums must be raised locally. In financing these township roads with state aid the town must supply at least 25 per cent of the funds, the state furnishing the remaining 75 per cent. There are, in the state, 232 townships with 13,700 miles of town roads. For the improvement of this mileage local interest must be awakened and it was for this reason that the state fair at Trenton seemed to offer an excellent opportunity for promotional work among the farmers.

The State Highway Department, therefore, selected a location along the Midway of the fair and constructed a 500-ft. section of oiled-cinder surface 16 ft. wide. Printed signboards at the roadside and an overhead banner call the attention of passers-by to the demonstration road and direct them for further information to the State Highway Commission's booth and exhibit.

The construction of this type of oiled-cinder surfacing is comparatively simple. It involves merely the shaping of the existing surface and the application of two layers of cinders, each of which is rolled with a 10-ton roller and sprinkled with water to form a 6-in. compacted thickness. A 55-per cent asphalt oil is then applied, cold, at the rate of ½ gal. per sq.yd. by a pressure distributor. The railroads in New Jersey, it is predicted, can furnish a plentiful supply of cinders.

In addition to the demonstration road, the State Highway Commission's exhibit includes a number of maps and photographs of road construction of all types and in various stages of completion. There are also samples of stone, sand and gravel, laboratory testing equipment, cores cut from concrete pavements, and a core-drilling machine mounted on a motor truck operated for the instruction of visitors to the fair.

As a result of this educational campaign a state-wide program of town-road improvement is expected.

Geological Survey Approves Texas Conservation Program

The program of the Texas Conservation Association organized at Waco, Aug. 16, after the conference of engineers called by Governor Neff in Austin, Aug. 6 (See *Engineering News-Record*, Aug. 17, 1922, p. 288) has been approved by the United States Geological Survey according to Homer D. Wade, secretary of the association.

Tunnel Driving Progress on the Hetch Hetchy Project

Of the 18 miles of tunnel now under construction on the mountain division of the Hetch Hetchy project which is to supply water and power for the city of San Francisco, 76,110 ft., or about 84 per cent, had been driven on Sept. 15. The accompanying table indicates the present rate of progress as shown by heading advances during June, as an indication of the current rate.

Plant and materials are being assembled at Priest Portal and at Big Creek shaft with which to place the concrete lining. At Priest crushers and screens have been installed and practically all the tunnel muck, which is now very hard granite and diorite, is being worked up into crushed rock and fines. The storage piles there on July 10 contained about 28,000 cu.yd. At Big Creek shaft a total of 13,000 cu.yd. of materials have been stored. Plans have been worked out for a new adaptation of the Web & Cox gun whereby concrete will be mixed in the tunnel at the point where the gun is at work, the materials coming in dry in batches suited to the mixer capacity.

The first concrete lining is expected to be placed through the Big Creek shaft. If the tunnel between Big Creek and Adit 8-9 is holed through about Oct. 1, as is now estimated, concreting is expected to start within thirty days thereafter.

Contract for driving the tunnel is held by the Construction Co. of North America, the lining work being sublet to the Universal Concrete Gun Co.

PROGRESS BY HEADINGS FOR THE MONTH OF JUNE, 1922, HETCH HETCHY TUNNEL

Heading	Tunnel Section	Character of Rock	Holes per Round	Superintendent	Shifts Worked*	Progress, Ft., June	Total Progress Ft., Sept. 15
Intake	13 ft. 4 in.	Monolithic granite to	45 52	Johnson	60	314	9,870
South Fork East	13 ft. 4 in.	Monolithic granite to	45 52	Peterson	59	313	10,230
Sough Fork West	13 ft. 4 in.	Granodiorite	38	Peterson	62	363	5,600
Adit 5-6 East	13 ft. 4 in.	Granodiorite	38	Gallagher	72	459	4,260
Adit 5-6 West	13 ft. 4 in.	Quartzite and Diorite	34	Gallagher	88	434	5,100
Adit 8-9 East	11 ft. 3 in.	Quartzite, Schists and Slates	25	Criddle	76	461	4,450
Adit 8-9 West	11 ft. 3 in.	Schists and Slates	25	Criddle	90	579	4,340
Big Creek East (Shaft)	11 ft. 3 in.	Schists and Slates	25	Fowler	59	395	6,390
Big Creek West	11 ft. 3 in.	Diorite	25	Fowler	59	397	8,060
Priest	11 ft. 3 in.	Granite and Diorite	30	Hickman	81	343	17,810
					706	4,058	76,110
				Average feet per shift		5.74	

* Cause of shifts lost were as follows:

Sough Fork	Water supply 1	1
Heading 5-6	Power, 2; timbering, 2; Trimming, 1	5
Heading 8-9	Timbering, 14	14
Big Creek	Broken skip, 2	2
Priest	Engineers checking tunnel, 1; power, 5; Accident, 3 (progress reduced account low voltage in power supply)	9
Total		31

Texas to Have Road Exhibit

The Texas Highway Association will have a complete road show and exhibit at the Waco Cotton Palace Exposition in October. The county engineers of the leading Texas counties are co-operating with the highway association committee composed of R. V. Glen, Ft. Worth, C. A. Clark, Dallas, and Pat Thompson, Arlington, to have models of recent Texas construction on display, thereby making it a most up to date exhibit. There also will be a large collection of highway photographs. The committee promises the most complete display of the kind ever shown in the State of Texas.

Eldridge Becomes Executive Chairman of A.A.A.

Maurice O. Eldridge, who has been director of roads of the American Automobile Association's Good Roads Board for the past three years and in direct charge of all legislative activities of the A. A. A., has been named as executive chairman of the association and has assumed active charge of the association's work throughout the United States. Mr. Eldridge was selected at a meeting of a special committee, named to select an executive chairman, which was held at Cleveland, Ohio, Sept. 20.

The new executive chairman brings to his task a record of 25 years of service in the U. S. Bureau of Public Roads. While assistant director of that bureau he performed much original research and development work on road and transportation problems, and for five or six years previous to associating himself with the A. A. A. he co-operated extensively with the late A. G. Batchelder in good roads programs. A graduate of the scientific school of George Washington University and a civil and highway engineer, Mr. Eldridge has made road problems his life work. He drafted the first federal-aid highway law, introduced by the late Congressman Brownlow of Tennessee, and was active in having the Dunn bill, which proposed to limit federal aid to $12,500 a mile for 1923 and $10,000 per mile thereafter, amended to allow federal aid of $16,500 per mile for 1923 and $15,000 per mile thereafter.

Brazilian Engineering Congress

(*Continued from p. 579*)

of the American Society of Civil Engineers, and other societies and one of the principal organizers of the congress. Mr. Havens' address was on the subject, "Problems and Duties of the Engineer," and brought out the necessity for the engineer to identify himself more broadly with the public affairs of his country.

The several papers that were read were nearly all of a practical nature as it had been specified that this congress result in actual tangible suggestions rather than be a scientific congress devoted to academic discussions.

Titles of papers which will constitute the annals of the congress follow:

"Utilization of Low-Grade Fuels With Seymour Pulverizers;" "Electrical Apparatus for High-Tension Power Transmission," Stephen Q. Hayes; "Economic Possibilities in the Use of Low-Grade Fuels of South and Central America, With Special Reference to Locomotive Requirements," Howard P. Quick; "Some Engineering and Construction Problems of the Panama Canal," S. B. Williamson; "Mammoth Cofferdam for Pier Construction in New York Harbor," Charles W. Staniford; "The Design of Masonry Dams," Edward Wegmann; "Technique of Radio Broadcasting," S. M. Kintner; "High Head Hydro-Electric Development in the Mountains of California," A. A. Northrop; "Long-Distance Telephony in the United States of America," Bancroft Gherardi and H. S. Osborne; "New Electric Furnace for Brass, Bronze and Copper," J. Murray Weed; "Factors Limiting Voltage of Long-Distance Transmission Lines," F. W. Peek, Jr.; "Large High-Voltage Oil Circuit Breakers," E. M. Hewlett; "Impressions of Cotton Textile Mills in the United States," R. L. Pamplona; "Present Status, Electric Furnace for Iron and Steel Industry," John A. Seede; "Concrete Piles and Concrete Piling Construction," Maxwell M. Upson; "Report on Development of the Cachoeria Paulo Affonso," Charles O. Lenz; "Building Mining Cities in South America," H. F. Guggenheim.

The Engineer in Public Life

A. B. ROBERTS

When Fred Kohler was elected Mayor of Cleveland, the Engineering Society of Cleveland was asked for the first time to suggest the names of men to be considered for the position of Director of Public Utilities, an office which, under the charter of Cleveland, is in reality the general manager of the Water Division, the Municipal Electric Light Plant, and the Heating Division. From the list submitted the Mayor picked Arthur Boardman Roberts, one of the directors of the Cleveland Engineering Society, and member of the Withington-Roberts-Wright Co., consulting engineers. Mr. Roberts accepted, and since Jan. 1, the $40,000,000 investment of Cleveland in public utilities has for the first time been under the supervision of a graduate engineer.

A. B. Roberts is 38 years old, was graduated from Case School of Applied Science as B. S. in mechanical engineering in 1907, and received honorary degrees of E.E. in 1914, M.E. in 1915, and C.E. in 1917. The regular work of training a young engineer during summers and when first out of school took him from Wyoming to Chesapeake Bay on various construction jobs. From 1908 to 1911 he was consulting engineer for the Standard Welding Co. and from 1911 to 1913, chief engineer of the 17 plants of the American Fork & Hoe Co.

In 1913 he went into private practice and was general manager of the firm which supervised the new plant of the Upson Nut Co., the Rubay Co., the Jordon Motor Car Co., the Shelby (Ohio) Municipal Light Co., Ohio Forge Co., and the American ship-building extensions at Cleveland, Lorain, and Chicago.

On Sept. 22, 1917, after entering the military service, Mr. Roberts reported for duty at Sandy Hook and until Jan. 28, 1919 he was in charge of the engineering design and construction of the Aberdeen Proving Grounds, built at a cost of approximately $12,000,000. He held a commission as major when discharged from the army. Beginning in 1919 he resumed connections with his private firm which engages in every line of construction except bridges. He resigned this year to become Director of Public Utilities in Cleveland.

Move Made to Dismiss Suit Against Water Power Act

Government Would Dismiss Petition of New York State Seeking to Restrain Permit Issuances

Washington Correspondence

Motion to dismiss the petition filed by the State of New York in the U. S. Supreme Court seeking to bring suit for an injunction against the Federal Power Commission to restrain the latter from issuing preliminary permits and licenses within the state has been filed by Solicitor General James M. Beck.

It is expected that the federal government's motion will be heard by the Supreme Court during the first month of its fall session, and that if dismissal be denied that Attorney General Charles D. Newton, of the State of New York, will apply for an advanced hearing of the state's petition. Without an advanced hearing, the case would not be reached on the ordinary docket for nearly two years.

The New York petition seeks to test the constitutionality of the water power act. The supporting brief filed by Attorney General Newton last May sets forth the claim that the Federal Power Commission is exercising authority which rightfully is reserved to the state; that it assumes jurisdiction over all streams other than brooklets, and that it is depriving the state of revenue. The license granted the Niagara Falls Power Co. and the preliminary permit granted the Lower Niagara River Power Co. accompany the petition as exhibits of the authority exercised by the commission.

In the petition to dismiss, Solicitor General Beck declares that the petition does not join essential parties as defendants; that it does not present any concrete question; that it does not present a controversy within the original jurisdiction of the Supreme Court; that it does not set forth any cause of action against the defendants—who are Secretaries Weeks, Fall and Wallace and Attorney General Daugherty; that the bill of complaint is without equity and that no concrete loss is established.

The government's motion sets forth the claim that if New York State has suffered any loss or injury because of the license issued the Niagara Falls Power Co. or the preliminary permit granted the Lower Niagara River Power Co., these corporations should have been made defendants to the petition.

Solicitor General Beck also recites various court decisions in support of his contention that the water power act is constitutional and that the Federal Power Commission is proceeding in a lawfully regulated manner.

Discuss Change in Rule of Road

The change in the rule of the road in eastern Canada is in confusion. New Brunswick was to change from left to right last spring at the suggestion of the New Brunswick Automobile Association and a bill to this effect was passed in the legislature. At that time it was thought that Nova Scotia and Prince Edward Island would follow the lead of New Brunswick, but opposition to the plan has arisen, and these provinces have not yet agreed to the change.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN PUBLIC HEALTH ASSOCIATION, New York; Annual Convention, Cleveland, Oct. 16-19.

The Municipal Engineers of the City of New York at its regular monthly meeting Sept. 27 was addressed by William W. Mills, deputy commissioner of the Department of Plant and Structures of the city of New York on the activities of his department, especially with respect to the municipal ferry service.

The Kansas City Chapter, A. A. E., held its first annual outing at the Ivanhoe Country Club, near Kansas City, on Sept. 16. More than fifty prizes, donated by various Kansas City business houses, were awarded to the winners of the athletic and guessing contests. A basket lunch was served followed by moonlight dancing to radio music, which was furnished by the broadcasting station of the *Kansas City Star*. This feature was highly successful.

PERSONAL NOTES

WESTON E. FULLER has withdrawn from the partnership of Hazen, Whipple & Fuller, consulting hydraulic and sanitary engineers, New York, to become professor of civil engineering at Swarthmore College. That firm will revert to the name of Hazen & Whipple, by which it was known during the period from 1904 to 1914.

L. W. KING, assistant county engineer of Cameron County, Texas, has resigned and has been appointed city manager of Brownsville, Texas, succeeding GEORGE GRUPE, resigned.

B. G. SLINING has returned to the Illinois Traction System, Peoria, Ill., as construction engineer, to become identified with an extensive program of power plant and transmission line construction in Illinois, Missouri and Kansas. Mr. Slining was construction engineer with this company in 1916 and 1917, leaving to take charge of the construction of the Standard Oil Co. coal-mining and power developments in Macoupin County, Ill.

CHARLES E. FRASER has tendered his resignation as president of the New York Harbor Dry Dock Co., Inc., in order to devote more effort to the general contracting business of Fraser, Brace & Co. George C. Clarke, formerly vice-president, has been elected president, and N. J. Kayser, works manager, has been elected vice-president. Messrs. Clarke and Kayser have been in charge of the operation of the dry dock since the inception of the project three years ago. Mr. Fraser will remain a director of the company.

A. H. DIMOCK, former city engineer of Seattle, has opened offices in the Central Building, Seattle, where he will engage in municipal, hydraulic, hydro-electric, water-works and sanitary engineering. Mr. Dimock was connected with the city engineering department for 25 years, and since 1911 had been city engineer.

FULLER & BEARD, engineers, St. Louis, Mo., has reorganized owing to the withdrawal of A. H. Beard. The firm is now known as the W. A. Fuller Co., W. A. Fuller, who has been actively engaged in engineering work for thirty years, continuing as the head of the company. A. H. Beard has opened his own engineering offices.

FRANK OSLER, for the past year supervising, management and construction engineer for Rose Polytechnic Institute, Terre Haute, Indiana, on the new layout of buildings, has become associated with O. C. Herdrich & Co. as consulting industrial management engineer.

J. H. BRILLHART, consulting engineer of Dallas, has taken over the management of the structural steel department of the Helm Mechanical Co., Ft. Worth. Mr. Brillhart is a past president of the Texas Section, Am. Soc. C.E.

FRANK A. MCARTHUR, city engineer of Guelph, Ont., has tendered his resignation to go into business for himself, having established the McArthur Engineering Construction Co.

A. W. SWAYZE, assistant to E. V. Buchanan, general manager of the Public Utilities Department at London, Ont., has resigned to become engineer with the Putherbough Construction Co. of London, Ont.

GEORGE C. WINCHEL, formerly chief engineer of the Industrial Engineering Co. of Akron, Ohio, and JOHN C. PAYNE, former city engineer of Akron, have opened offices at 600 Second National Bldg., Akron, Ohio. They will handle general industrial plant engineering in addition to their present civil engineering practice. Several well-known Akron engineers will be associated with this firm.

GEORGE ACKER, who has been for nearly five years inspector of material with the Submarine Boat Corp. of Port Newark, N. J., has been appointed engineering inspector for the New York & New Jersey Interstate Bridge and Tunnel Commission on the vehicle tunnel under the Hudson River.

R. V. DAVIDSON, recently engineer for the Northern Texas Traction Co., Ft. Worth, on the surveys for the Ft. Worth-Lake Worth Interurban is now office engineer under R. V. Glenn, consulting engineer, Tarrant County, Tex., Highway Dept.

A. B. DEAN, former maintenance engineer of Walla Walla County, Wash., is to be retained as deputy county engineer according to recent advices. Mr. Dean will replace Earl Kennedy who recently resigned.

J. GUITON MORGAN has been appointed by the state highway department to be bridge engineer for Palo Pinto County, Tex.

J. W. BEARDSLEY, civil engineer of New York, has left Spokane for Marble, Stevens County, Wash., to take charge of the Marble irrigation project. It is expected that plans and specifications will be ready about Dec. 1.

J. M. FELKNOR has been selected by the supervisors of Colusa County, Calif., to supervise the construction of approximately 50 miles of highway. Funds are available from a bond issue recently authorized.

R. E. YOUNGS, of Livingston, has been appointed county engineer of Liberty County, Tex.

FRANK C. TOLLES, formerly superintendent of public works for Akron, Ohio, announces his association with the firm of Swigart and Ehrman, of that city, for the general practice of engineering.

OBITUARY

C. C. THOMPSON, former city engineer of Phoenix, Ariz., was killed by lightning recently while in the Harqua Hala mountains running the division line between Yavapai and Maricopa counties in that state.

EDGAR B. TYLER, of Decatur, Ill., vice-president and member of the board of directors of the Mississippi Valley Structural Steel Co., died Sept. 27 in St. Louis, Mo.

CHARLES B. FALLEY, captain, Corps of Engineers, U. S. Army, died at the army base hospital, Fort Sam Houston, Tex., Sept. 22, 1922, following an operation. Capt. Falley was assigned to the Second Engineers and was serving as assistant to the engineer of the eighth corps area.

WILLIAM H. SCHMIDT, a civil engineer having offices in New York City, died Sept. 29 at his summer home at Bay Shore, Long Island, after an illness of two years. Mr. Schmidt was second vice-president of the Commonwealth Bank and a trustee of the Citizens Savings Bank. He as a graduate of Cornell University and had been connected with the United Engineering & Contracting Co., which helped build the Pennsylvania tubes under Manhattan Island, and had done work for that company in Cuba.

RICHARD B. ANGUS, Canadian financier and director of the Canadian Pacific Ry., died, after a protracted illness, Sept. 17 at Senneville, Que., in his ninety-second year. He was a native of Scotland and came to Canada in 1857 taking a position on the staff of the Bank of Montreal. In 1869 he became general manager. Ten years later he turned his attention to railway enterprises and was one of the first promoters of the Canadian Pacific Ry. With him in the original syndicate was George Stephen, later Lord Mount Stephen, and Donald A. Smith, later Lord Strathcona. In 1910, at the age of eighty, Mr. Angus became president of the Bank of Montreal, from which office he resigned in 1913. He was prominently identified with many other industrial and commercial enterprises. He is survived by three sons and four daughters.

From the Manufacturer's Point of View

Need More Mechanical Plant at American Ports

This is View of G. E. Titcomb, Returned from Five Months' Inspection of European Parts

IN COMPARISON with European practice docks at American ports are underequipped with cargo-handling machinery. This is one of the main impressions brought back from a five months' trip abroad by George E. Titcomb, New York manager for the McMyler Interstate Co. of Cleveland, manufacturer of a wide variety of ship and locomotive cranes, car dumpers, buckets, and other material-handling plant. His opinion, as expressed during a recent interview with *Engineering News-Record's* representative, is based upon a study of conditions not only at English seaports but also at those in Holland, Germany, France, and Spain. For general industrial and construction use, however, the locomotive crane figures more prominently in America than in Europe.

Mr. Titcomb's trip was devoted primarily to a study of cargo cranes and coal- and ore-handling machinery with a view to securing data applicable to the solution of American port problems and to the improvement in design of material-handling machinery. Plans of European port organization, he pointed out, necessitate methods and equipment different from those employed in the United States. In the London port area, for example, a large percentage of the incoming freight from vessels is delivered to lighters for distribution to the quays.

One of the conditions favoring adequate mechanical equipment of British ports, Mr. Titcomb emphasized, is the policy of putting back into improvements and maintenance the bulk of the revenue received. In other words, the funds coming from the shipping interests do not go into the city treasury, but are set apart for the particular use of the Port Authority, as contrasted with the situation in New York where rentals from piers revert to other municipal uses. In the case of the Port of London, the directors, in whose hands is placed the entire operation, are elected by the interests, both shipping and railway, that pay the dues. Under this scheme of operation the importance of adequate cargo-handling facilities is fully appreciated and proper equipment is installed.

While in general Mr. Titcomb noted a similarity in the type of cranes employed in American and European practice, there was one notable exception. This was an English type of horizontal luffing cane with balanced boom, so designed as to require a comparatively small motor for luffing and insuring flexibility of control. In this type of crane the load travels horizontally in spite of upward or downward movements of the boom. Mr. Titcomb was very favorably impressed with the design and operation of this type of crane. In the opinion of English stevedores operating cranes of this type 50 per cent more freight can be handled from steamer to quay than with the ordinary type of revolving gantry crane. With a 3-ton load the luffing cranes have a lifting speed of 150 ft. per minute; luffing, 180 ft. per minute; slewing, 1½ r.p.m.; and travel 100 ft. per minutes.

Both in England and on the Continent a definite trend toward the wider use of mechanical equipment for cargo handling was noted. In the erection of every new terminal great stress is being placed upon the adequacy of freight-handling machinery. This is particularly the case at the new Holland-American line piers in Rotterdam.

Engineers Discuss Plan to Reduce Asphalt Varieties

Patterson Favors Uniformity—Forrest Gives Views on Penetration and Other Tests

IN LAST week's issue, (p. 539) there appeared an article presenting arguments from the manufacturer's point of view on the desirability of having fewer different grades of asphalt for road and paving work. As a result of *Engineering News-Record's* invitation for comment on this general subject the following discussion has been received:

IRVING W. PATTERSON
Chief Engineer, State Highway Department, Providence, R. I.

I believe that the point of view of the asphalt manufacturers, as explained in the article in the Sept. 28 issue of *Engineering News-Record*, is very well taken. I have felt for a long time that there is needless variation in asphalt specifications. I am of the opinion that specifications for asphalt should be more nearly standardized than they are today.

C. N. FORREST
Manager, Technical Dept., Barber Asphalt Co., Maurer, N. J.

I have read with interest the article on "Too Many Grades of Asphalt" which appears in *Engineering News-Record* of Sept. 28, under the new department, "From the Manufacturer's Point of View."

The ostensible purpose of this article is to encourage greater uniformity in specifications for paving asphalt as to penetration (consistency), so that a few appropriate standards may be established and the procedure of the manufactures thus simplified. While the consistency of a paving asphalt is an important characteristic it is not so vital as to require adjustment within narrow or unusual limits, and even less than the 7 standard grades of consistency proposed would in my opinion suffice for all practical purposes.

It will be noted that the penetration standards proposed in the article overlap and as this is also undesirable the following classification is offered.

Asphalt Macadam (Penetration Method)	130 to 150
Asphalt Macadam (Mixing Method)	100 to 125
Asphaltic Concrete } Sheet Asphalt }	50 to 60 35 to 45 25 to 30

It is conceded that the limit of accuracy of the penetration test is "not more than four points between maximum and minimum."

In the writer's experience, there is no reason to vary the consistency of the asphalt for use in asphalt macadam on account of climatic conditions. If the grading of the mineral aggregate in use does not produce the desired results with asphalt of the consistency provided in the above schedule, then it, and not the asphalt, should be changed, because the grading is probably too fine and a harder or softer asphalt will not correct such a difficulty.

Three different consistencies of asphalt are sufficient for any variations in climate or traffic, practically the world over, for asphaltic concrete or sheet asphalt.

While the writer is in sympathy with the movement to reduce the number of different consistencies of asphalt which may be specified he does not concede that "the keynote test for asphalt quality is that of penetration" nor that the specifications on all other characteristics of asphalt can be advantageously reduced to stereotype form. The penetration of asphalt is an adjustable characteristic and denotes only a degree of hardness regardless of any other physical or chemical characteristics which may be inherent in the substance or imparted to it by manipulation in the process of production.

The original sources of supply of paving asphalt as well as the processes employed in its production are various. Consequently, it is not all alike even though it may all be of the same penetration or series of penetrations.

Standardization of a limited number of grades of asphalt as to penetration would be of considerable advantage to the manufacturer without any disadvantages to the highway engineer or the public at large, and this should be done, but as penetration is not a criterion of quality, it does not necessarily follow that all of the other features of the specifications for asphalt may also be unified either as to the kind of tests or the limits of the results thereof, without disadvantage to the consumer.

In the writer's opinion this latter should not be done.

Business Notes

HERBERT C. FOLLINGER, manager of the Chicago office of the Chain Belt Co., died of pneumonia at his home in Chicago on Sept. 27. He had been ill but a few days. Mr. Follinger was 38 years of age, and was born at Fort Wayne, Ind. In 1902 he was graduated from the Chicago Manual Training School, now part of the University of Chicago, and entered the employ of the Otis Elevator Co. He became associated with the Chain Belt Co. in 1914, and in 1916 was appointed district manager for the Chicago territory.

F. S. PEARSON ENGINEERING CORP., New York City, has reestablished its department for industrial management and technical auditing of industries and public utilities.

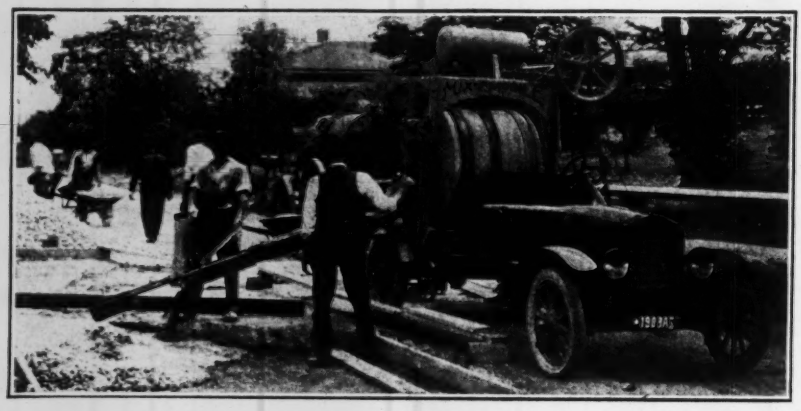
Equipment and Materials

Shovel Patents Valid

By decision of Judge Buffington in the Circuit Court of Appeals, Third Circuit, the Surbaugh patent, U. S. No. 1,212,582 on hand shovels is held to be valid. The patent covers the two-prong or double-frog type of coal shovel or scoop controlled by the Pittsburgh Shovel Co., under the trade names "Coal Bluff" and "Pacemaker."

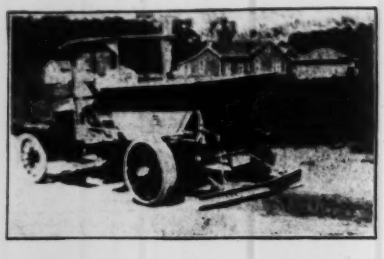
Road Maintenance Truck

For highway maintenance work a truck with hopper body and adjustable scraper, known as the "Patrol," has



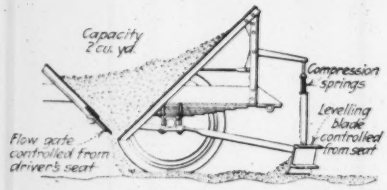
just been placed on the market by the Greenville Manufacturing Co., Greenville, Ohio.

The truck holds 2 cu.yd. (3 tons) of gravel or stone and is constructed with a long narrow sliding gate extending entirely across the lower extremity of



the front sloping side of the body. This gate can be opened 1, 2, 3, or up to 6 in., creating a long slot which permits an even flow of material across the roadway the full width of the body. An adjustable scraper or levelling blade attached to the rear axle and also controlled from the driver's seat, further spreads the material and levels it over chuck holes, ruts, etc.

One side only of the gate opening can be used permitting the filling of chuck and mud holes on either side of the road without spreading material over the entire surface. The truck has also been used as a power unit for



pulling light road graders and other machines.

The machine has a speed of from 12 to 15 miles per hour and is built on a standard Ford truck chassis. The front half is entirely of Ford design and the rear half is of 3½-ton truck construction with wheels, axle, springs, etc., to correspond. The "Patrol" sells for $1,350 f.o.b. Greenville, Ohio.

Concrete Mixer Combined With Ford Truck

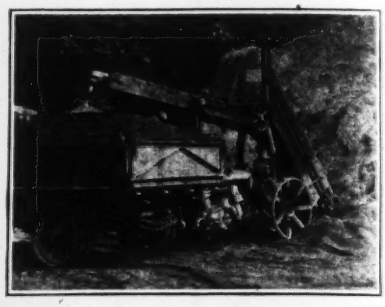
For the purpose of obtaining mobility on comparatively small concreting jobs, such as building foundations, sidewalks, curbs and gutters, the Milwaukee Concrete Mixer Co. has adapted one of its 7-cu. ft. mixers to a 1-ton Ford truck. The mixer is operated through pin-wheel drive from the 20-hp. engine of the truck. Levers are all within range of the driver or from a position on the ground. By removing four clamps the mixing mechanism can be removed and the "Mixermobile" converted into a one-ton truck.

Power-Driven Elevating Loader Mounted on Tractor

A portable elevating loader in which mobility is secured by mounting on a Fordson tractor, which serves also as the power plant, has been put on the market by the Specialty Engineering Co., Philadelphia. The loader consists of three main parts: the frame, the elevator and the conveyor. The general arrangement is shown in the accompanying photograph. Steel buckets are operated by endless chains and work on rollers which are claimed to be a distinctive feature. The conveying mechanism is of conventional endless-belt type and moves the material forward beyond the front end of the tractor where it is dumped into trucks or wagons. The frame consists of four uprights attached to the tractor.

Power is taken from the shaft of the tractor through a sprocket wheel which, by means of a chain drive, operates a sprocket on the loader. The loader weighs approximately 5,500 lb., 80 per cent of which is carried on the rear axle. In operation the loader backs into the material to be handled, trucks being spotted in front of the machine. In moving from one job to another the elevator is raised so that it has the same clearance as the tractor.

The photograph shows the equipment loading anthracite river coal at Reading, Pa., this is a very fine material and resembles sand. The machine is designed, however, for

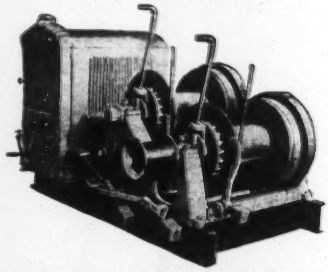


handling any kind of loose material such as sand, coal, gravel, earth, and stone.

The loader has an overall length of 11 ft. 3 in. and the point of discharge of the belt conveyor is 8 ft. 6 in. above the ground. The buckets are 8 x 16 in. and are equipped with steel digging edges riveted in the corners. The belt conveyor is of rubber, 18 in. wide. The loader may be attached to a standard Fordson tractor without the necessity of drilling holes or making any other alterations.

Double-Drum Hoist With Multiple Cylinder Gasoline Engine

Several advantages are claimed by the O. K. Clutch & Machinery Co., Columbia, Pa., for its double-drum hoist equipped with four-cylinder, 15-hp. gasoline engine. The design of the engine is similar to that of a motor truck, but is adapted to meet the heavier demands of hoisting. This machine, it is claimed, is considerably lighter than the ordinary single-cylinder stationary-engine type of hoist,



takes up less space and can be moved more readily. Repairs, when necessary, can be made in almost any automobile garage. These hoists are manufactured in three sizes, 8, 12 and 15 hp., have hoisting speeds from 125 to 150 ft. per minute, and will lift 1,500, 2,200 and 2,800 lb. respectively. In comparison with a steam-operated hoist it is pointed out that no time is lost in firing a boiler.

The asbestos-lined, cone friction drums, the manufacturers state, require no adjustment and will not swell

from moisture. Self-oiling phosphor bronze bushings and powerful asbestos lined foot brakes are other features of the equipment. Extra large machine-cut gears are used throughout and the driving pinion is made of solid machined steel.

Bascule Bridge Litigation Settled

The dispute between the city of Seattle and the Strauss Bascule Bridge Co., which resulted in a suit for $350,000 by the latter against the city for alleged infringement of patents in the construction of the three bridges across the Lake Washington canal, has been settled out of court and the construction of the Spokane St. bridge across the Duwamish Waterway is now expected to proceed. On the terms of settlement the company will furnish the city with complete plans for the Spokane St. bridge, which the city may use or not. For these plans, the company will receive $50,000, and if they are adopted an additional sum of $25,000.

Improvements Made in New ¾-Yd. Revolving Shovel

Announcement is made by the Osgood Co., Marion, Ohio, of a new ¾-yd. heavy duty revolving steam shovel similar to the Osgood 18, which it is to replace. A complete redesign of the continuous tread mountings has produced an all-gear propelling drive, increased the bearing surface of the treads on the ground and simplifying construction.

The driving and idler tumblers have been made round to reduce vibration when traveling and produce smoother action of the tread belts. The drivers have teeth on the sides which contact with the guiding flanges of the tread links for driving the belts. This eliminates tooth pockets in the face of the treads and the trouble and inconvenience of these pockets becoming clogged. With the tread links overlapping as they do an unbroken bearing surface is provided.

Improvements have been made in the steam cylinder steering mechanism which is controlled by a single lever in the cab. The steering clutches have jaws of the self-cleaning type.

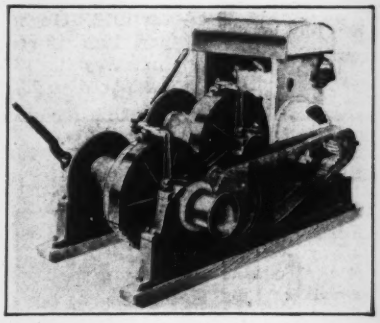
The wheels on the traction machine have been increased to 36 in. in diameter and the rims strengthened. The rear or driving wheels have been increased in width to 20 in. and fitted with the usual bolted-on diagonal cleats. The front or steering wheels have 16 in. face and bushed with bronze for the axle.

The vertical center shaft carries an adjusting nut at both the top and bottom ends so that the shaft can be tightened either from above or below. The lugs extending forward from the body center casting which support the boom foot have been set ahead 6 in. This gives a longer digging radius, wider cut at floor level, longer dump and better cleanup.

The new design retains such features of the Osgood 18 model as: Submerged tube type boiler; horizontal, long-stroke, hoisting engines; double-gear shipper shaft; large centering gudgeon around center shaft; and swinging mechanism with all adjustments above deck.

Silent Chain Drives Gasoline Hoist

Gasoline hoists made by the Clyde Iron Works are now equipped with silent chain drive connecting the motor



and friction drums. The hoisting drums and motor with all accessories are mounted on a single bed plate making a self-contained unit. The hoists are made with one, two or three drums.

Publications from the Construction Industry

Trailers and Tractors—GENERAL MOTORS TRUCK CO., Pontiac, Mich., and the DETROIT TRAILER CO., Detroit, Mich., have issued, jointly, a 32-p. illustrated booklet entitled "Modern Freight Transportation," which gives details regarding the two types of highway transport unit and illustrates their use, together, in hauling gravel, lumber and other construction materials in addition to general merchandise. It is claimed by the two companies that this is the first instance of a truck manufacturer and a trailer manufacturer co-operating in the publication of a joint catalog for the trucking public. Tractors are illustrated in 5, 10, and 15-ton capacities. One of their features is a two-range transmission by means of which maximum pulling power is developed only when needed in starting the load and running on poor roads, making possible the use of a relatively small and economical motor. This transmission, it is pointed out, delivers a much wider range of gear reductions than is possible in a four-speed transmission. The portion of the booklet devoted to trailers and semi-trailers illustrates a wide variety of types, ranging from 15 tons' capacity downward. In addition to the various standard forms of semi-trailer, there are special types among which may be noted a 15-ton drop frame trailer for carrying transformers, electric generators, and cable reels. A special 20-ton, four-wheel "Big Devil" model is designed particularly for heavy tonnages of structural steel. Trailers with both open and inclosed bodies are shown, sometimes in trains of three units. A feature of the Detroit four-wheel trailers is a patented swivel draw-head, compelling the trailer to follow the true line of the truck. For municipal work, such as the handling of garbage and refuse, a gravity drop frame, dump-body type, with capacities from 2 to 7 tons, is illustrated. At the end of the booklet is a large chart giving detailed operating costs per 100 miles for five representative truck-trailer combinations.

Swing Hammer Pulverizers—JEFFREY MANUFACTURING CO., Columbus, Ohio, describes and illustrates three types of swing-hammer pulverizers in a 42-p. catalog just issued. These machines operate on the principle of reducing material by striking it while in suspension, as opposed to the attrition mill which masses or rolls the substance between two hard surfaces. In the Jeffrey pulverizers the material is fed into the top of the machine and in falling comes in contact with rapidly revolving hammers which drive it against breaker plates from which it rebounds again into the path of the hammer. Three types of machine are manufactured, one for general purposes, a second for breakdown machines and fine grinding, and the third for grinding limestone and similar rock. The Type A plant is adapted to crushing rock for road construction.

Aids to Traffic Control—AMERICAN GAS ACCUMULATOR CO., Elizabeth, N. J., has issued a 14-p. pamphlet entitled "Traffic Engineering," by G. G. Kelcey, illustrating, both in text and diagrams, methods of handling traffic at street intersections and preventing accidents. Several cases of typical traffic situations at intersections are discussed and the advantages of rotary traffic are emphasized. The company manufactures a small marine-type "lighthouse," designated as the flushing traffic beacon for use at highway intersections to regulate the passage of vehicles. It is an independent unit requiring no wiring as acetylene light is used.

Nailing Base for Floors — PAUL MENDE, INC., New York City, has issued a 4-p. folder describing Nalecode, a compound of powdered fibrous minerals which, when mixed with portland cement, sand and water, makes a plastic mortar that sets. Nails or screws may be driven into it.

Business Side of Construction

Facts and Events that Affect Cost and Volume

September Contracts Show Higher Average Weekly Rate Than Preceding Month

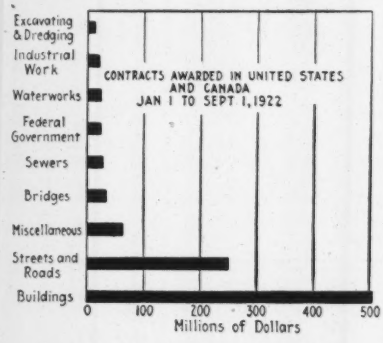
Awards Aggregated $138,648,000 in Four Issues of September Against $160,130,000 in Five August Issues

Contracts awarded on important engineering projects, as announced in the four September issues of *Engineering News-Record*, aggregated $138,648,000 as against $160,130,000 reported in the five August issues. This represents an average weekly rate of $34,662,000 as compared with $32,026,000 for August. Contracts awarded in Canada totaled $7,833,000 leaving $130,815,000 as representing contracts let on important engineering construction in the United States. The rate for September, 1921, was $24,694,000 per week, which is over 40 per cent lower than this year.

The minimum costs observed in Construction News, on each class of construction, are as follows: water-works, $15,000; other public works, $25,000; industrial construction, $40,000, and commercial buildings, $150,000.

The weekly average for commercial buildings during September totaled $14,670,000, which compares very closely with $14,702,000, the weekly rate for August. Likewise, streets and roads attained an average of $7,221,000 during September, with the rate for August at $7,407,000 per week.

Although letings in the Middle Atlantic States, on all classes of construction, exceeded those in the Middle West, during September, the slow swing in the construction of new buildings from the New York-New Jersey district to that part of the Middle West centered in Chicago is indicated in reports to the Housing Division of the Department of Commerce. The East, however, continues its lead in the construction of apartment houses and dwellings. There is no indication, thus far, according to reports received by the Division, of the effect of increasing prices of construction materials upon future contracts. The general tendency of building materials prices continues upward as shown by the Department index number of 172.4 for August as against 169.6 for July. The *Engineering News-Record* Construction Cost Index Number for July was 169.7; August, 173.4; September, 185.0 and is now 188.6.



Large contracts awarded in all classes of construction from Jan. 1 to Sept. 1, 1922, totaled over $1,059,000,000, as reported by the *News-Record*. Buildings comprised the bulk of the total money value. Streets and roads came next followed by "Miscellaneous" construction, with public works last. The accompanying chart shows the proportions in which contracts were awarded according to classifications, during the eight months.

Residential building in twenty-seven states in the eight months aggregated $887,251,700, according to F. W. Dodge statistics. The New York district was the heaviest, $314,387,200, followed in order by the Chicago, Philadelphia, Pittsburgh, Boston and Minneapolis districts. The last district reported only $17,819,000.

Engineering News-Record Construction Cost Index Number

October, 1922	**188.60**
September, 1922	185.00
October, 1921	182.57
Peak, June, 1920	273.80
1913	100.00

Engineering News-Record's Construction Cost Index Number is 3.6 points higher than last month, due to advances in prices of steel and cement. Steel is now $2.00@$2.25, Pittsburgh mill. Lumber and cement advanced generally. The average rate for common labor remains at 45c. Thus, general construction cost is only 3 per cent higher than one year ago and 31 per cent under the peak; it is 88.6 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Monthly	
September, 1922	**129**
August, 1922	154
September, 1921	114
1913	100
Yearly	
1921 (entire year)	88
1920 (entire year)	91
1913	100

Engineering News-Record's Construction Volume Index Number is 129 for the month of September, and 88 for the whole of 1921, as against 100 for 1913. This means that the actual volume of construction in 1921 (not the mere money value of the contracts let that year) is 12 per cent under the volume of construction for 1913. Our monthly volume number, 129 for September, 1922, is really the increment of construction, and indicates the rate at which contracts are being let as compared with 1913 awards.

VALUE OF CONTRACTS LET IN THE UNITED STATES AND CANADA IN SEPTEMBER, 1922

	New England	Middle Atlantic	Southern	Middle West	West of Mississippi	Western	Canada	Total
Waterworks	$1,358,000	$99,000	$460,000	$556,000	$338,000	$850,000	$245,000	$3,906,000
Sewers		780,000	121,000	1,957,000	377,000	38,000	67,000	3,340,000
Bridges	80,000	200,000	1,655,000	566,000	321,000	175,000	35,000	3,032,000
Excavating and dredging	25,000	61,000	61,000	220,000	326,000	127,000	56,000	876,000
Streets and roads	835,000	5,556,000	6,503,000	7,057,000	5,104,000	3,268,000	561,000	28,884,000
Industrial Works	4,020,000	4,381,000	363,000	6,210,000	380,000	225,000	3,000,000	18,579,000
Buildings	7,293,000	21,128,000	1,693,000	15,207,000	9,420,000	1,160,000	2,780,000	58,681,000
Federal Government Works	103,000	3,118,000	1,321,000	60,000	1,180,000	1,887,000		7,669,000
Miscellaneous	3,025,000	6,010,000	119,000	2,700,000	626,000	112,000	1,089,000	13,681,000
Total	$16,739,000	$41,333,000	$12,296,000	$34,533,000	$18,072,000	$7,842,000	$7,833,000	$138,648,000

Coal Output Hampered by Lack of Cars and Poor Transportation

"Normal production of anthracite is being retarded by the same conditions that hamper the soft-coal industry—lack of cars and poor transportation," states *Coal Age*, reviewing conditions in the current coal market. The report continues: "There also is a dearth of labor. The effect of the car shortage is only just now being felt. During the last four days of September the supply began to be "spotty," incurring delays at collieries located on the Lehigh Valley, Erie and D. L. & W. lines. Deliveries are slow, some loads destined to New York Tidewater on Sept. 11, 12 and 13 not having been received three weeks later and sidetracks being congested with coal awaiting pulling.

"The anthracite price situation is confusing. Retailers have received independent quotations ranging $9.15@$13 and even higher and are loath to pass this on to their trade. The $8.50 price recommended by the Pennsylvania commission did not hold water and the commission now urges that, pending further investigation and adjustment, operators refrain from charging prices exceeding those established in 1920 by the Fair Practice Committee, which prices ranged up to $12.50, averaging around $10.50.

"With 25 per cent of their motive power out of commission the railroads of the country are now attempting to handle the peak of the year's business. There are no signs that the crest has been reached. Traffic men believe that business will be offered the railroads in increasing amounts more rapidly than its locomotives can be repaired."

Labor Rates and Conditions Throughout the Country

The return to work of several hundred thousand coal miners, railroad shopment and textile workers, together with a general increase in employment during the month, marks the beginning of a temporary upward trend in labor costs. The most important wage increases occurred in the metals, textile and construction industries.

Despite the wage increases and the fact that general business progress is being greatly hindered by freight congestion, industrial conditions throughout the country, show marked improvement from week to week.

As wages become more and more sensitive to price fluctuations, labor problems of a local character begin to appear. For instance, advances in the common labor rates in Philadelphia and Baltimore are offset by adjustments in the schedules in Cincinnati, Kansas City, Pittsburgh and St. Louis, resulting in a common labor rate for the entire country of 45c. per hr., exactly the same as the average for September. This average rate, however, applies to unskilled, non-union, common labor only, and does not include the semi-skilled.

Local industrial conditions as reported by *News-Record* correspondents are given as follows:

Atlanta—Situation somewhat upset, owing to strike conditions and heavy demand for materials and men. Building going ahead despite trouble.

Baltimore—Skilled building trades mechanics in sufficient numbers; scarcity of common laborers.

Birmingham—No change in labor rates or conditions since 20 per cent advance in steel mills. Stocks of all materials piling up, owing to lack of cars.

Cincinnati—Shortage of bricklayers, carpenters, hodcarriers and common laborers. Supply of structural ironworkers and hoisting engineers, normal.

Denver—Labor, all classes, 100 per cent employed. Some trouble reported due to car shortage, principally in the cement industry.

Detroit—Labor rates and conditions unchanged during month. Supply and demand in all trades about normal.

Kansas City—Plenty of all classes of building trades mechanics except carpenters. Hoisting engineers, one drum, receive $1 per hr., two drums, $1.25. Hodcarriers paid 75c.@80c. as against 80c. per hr. and pile drivers, $1 as compared with 85c@$1 per hr., formerly. Structural ironworkers reduced to $1 as against $1.07½. Common labor rates range from 40c.@65c. per hr. as compared with a minimum of 60c., last month.

Cleveland—Hoisting engineers advanced to $1.1 per hr., from $1.04.

Montreal—Plenty of common laborers but scarcity of bricklayers. Ample supply of other trades.

New York—Shortage of building trades mechanics in all parts of Metropolitan District. Unusually large amount of brick construction under way for this season of the year, resulting in an equally unusual demand for bricklayers, hodcarriers, etc. Labor costs increasing in certain skilled lines, particularly the finishing trades.

Pittsburgh—Scarcity of bricklayers, carpenters and common laborers. Other trades plentiful. Hodcarriers raised to 90c. as against 80c. per hr. but common labor rate at maximum of 50c. as compared with 50c.@60c. per hr., last month.

St. Louis—Foremen bricklayers receive $1.62½ per hr. Scarcity of mechanics; paying as high as $1.37½. Carpenters have withdrawn from Building Trades Division of A. F. of L.; threaten strike over jurisdictonal dispute. Union common laborers receive 57½c. as compared with 30c.@40c. for non-union. Rate for concrete men, 69c.; finishers, $1 per hr.

San Francisco—Plenty of work for all classes of building trades mechanics; seasonal rains not having begun, as yet.

Philadelphia—Scarcity of bricklayers. Sufficient work for all trades.

(Higher rates indicated by +, decreases by—)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$0.90	$0.70	$0.70	$0.30	.....	$0.65	$0.30@.35
Baltimore	1.25	.80	+.87½@.90	+.60@.75	+$0.75	1.00	+.35@.40
Birmingham	1.00	.75	.50@1.00	.15@.25	.....	1.00	.15@.20
Boston	.90	.90	.90	.60	.90	.90	.35
Cincinnati	1.25	.95	.95	.72½	.....	.95	.35
Chicago	1.10	1.00	1.10	.....	1.10	1.05	.72½
Cleveland	1.25	1.04@1.10	+1.10	.60	.91	1.10	.57½
Dallas	1.00	1.00	1.00	.60	1.00	1.00	.25
Denver	1.25	1.00	1.00	.75@.81¼	1.00	1.03⅛	.35@.50
Detroit	1.12½	.80	.80@.90	.50@.60	1.00	.60@.80	.50
Kansas City	1.07½	1.00	1.00@1.25	−.75@.80	+1.00	−1.00	.40@.65
Los Angeles	1.25	1.00	1.00	1.12½	.87½	1.00	.56¼@.62½
Minneapolis	1.00	.80	.80	.65	.....	.80	.35@.50
Montreal	.90	.65	.50	.35	.50	.55	.30@.35
New Orleans	1.00	.85	.90	.50	.80	1.00	.35@.40
New York	1.25	1.12½	1.25	.87½	1.00	1.12½	.44@.60
Pittsburgh	1.30	1.12½	1.00	+.90	1.00	1.00	.50
St. Louis	1.25	−1.10	1.12½	.85	+1.12	+1.12½	.30@.40
San Francisco	1.12½	1.00	1.00	.75	1.00	1.12½	.47½@.50
Seattle	1.00	.80	.90	.70	1.00	.80@.90	.50@.60
Philadelphia	+1.25	.90	.90	.75@90	1.00	+.90@1.00	+.35@.40

Extensive Concrete Paving Work in South and West

Within the next year Houston, Tex., will spend $2,000,000 on new pavements. The first of these contracts has been delayed because of a difference of $20,000 in a $160,000 job. A paving company bid $20,000 under all others on a proposal to use a rock asphalt that had never been laid in Houston before.

In the first seven months of 1922 a total of 136 concrete-paving contracts have been made in the state of Washington, according to the Portland Cement Association. Of these jobs twenty-six were state and county projects and 110 were city street-paving jobs. The former totaled 926,172 sq.yd. and the latter 850,197 sq.yd. or a grand total for both classes of 1,776,369 sq.yd. This is 84 per cent of the total yardage contracted in the state of Washington during the entire twelve months preceding.

Some idea of the average cost per mile of concrete paving work in the South, may be gained from the following record of contracts awarded for road work, totaling $3,500,000, in two months.

During April, the North Carolina Highway Commission let six highway projects and one bridge project. The total length of this work was 51.43 miles, and the cost, exclusive of the usual 10 per cent for engineering and contingencies, was $1,031,140. Of this mileage, 19.67 miles were of standard hard-surface construction, i.e. plain or reinforced concrete or some asphaltic type on a 5-in. concrete base. The average cost per mile for roads of this type with 18-ft. pavements, including clearing, grading, draining, reinforced concrete structures, was $33,059.

On 22.89 miles of standard earth, sand-clay, topsoil, and one-course gravel construction the cost per mile averaged $8,272, including clearing, grading, draining, reinforced concrete structures, etc. On 8.87 miles of two-course gravel and waterbound macadam the cost was $15,500 per mile.

During May the Commission let 15 highway projects and one bridge project. The total mileage involved was 142.54, and the cost, exclusive of the usual 10 per cent for engineering and contingencies, amounted to $2,532,709. Of this mileage, 62.75 miles were of standard hard-surface construction, with widths about equally divided between 16 and 18 ft.; the average cost per mile $31,176.

Finance Briefs

Stock market prices broke sharply during week due to uncertainty of Near East situation. No important upward movement since peak, Sept. 11. Buyers cautious.

Bond Market showed substantial recoveries at close of week. Municipals quiet; fair demand for new issues. Liberty bonds below par, first time in six months. Declines in railroad and industrial obligations. Foreign securities affected by news of Turkish advance. Public utilities show greatest improvement of week.

Foreign Exchange affected by Near East situation. Sterling dropped sharply during week to $4.36¼, lowest since Mar. 28. French, Italian, German and other continental rates lower.

Money Market steady for time loans, bidding 4½ per cent on maturities from ninety days to six months. Call money, 4½@5 per cent as against 3½@6 per cent, last week.

Railroad Shops Getting Back to Normal Basis

Restoration of normal conditions in the railroad shops continues rapidly and the Association of Railway Executives reports that 372,000 men, approximately 88 per cent of the normal force, are now at work.

Nineteen roads having a mileage of 54,056 miles, or 23 per cent of the total mileage of the country, are reported to have settled on the basis of the so-called Willard-Jewell compromise negotiated at Chicago and reported in *Engineering News-Record* of Sept. 21, p. 492. Several roads are still in conference with the shopmen's union.

Monthly Prices of Construction Materials

Ups and Downs of the Market

No reports received this month from Boston, Dallas and Los Angeles.

Pig Iron—Despite stiff advances during month, pig-iron prices show tendency to soften. No. 2 foundry, averaging $33@$35; basic about $34 and bessemer at a maximum of $35 per ton, valley base. Coke production gaining with prices slightly lower.

Railway Supplies—Standard rails, $43 as against $40 per ton, f.o.b. mill, effective Oct. 1. Bessemer rails were $45, one year ago; openhearth, $47. Light rails, spikes and track bolts higher at Pittsburgh mills. Douglas fir railway ties up in San Francisco; red oak, in St. Louis.

Pipe—Discounts reduced 5½ points on black and galvanized wrought-iron pipe since recent change on Pittsburgh basing card of Aug. 23. Recent pig-iron shortage reflected in advances in cast-iron pipe of $3 in Birmingham and $2 per ton in Chicago. Recent softening of pig-iron market has not yet affected pipe. Sewer pipe higher in Pittsburgh, Birmingham, St. Louis, Cincinnati and Atlanta; clay drain tile up $5 per 1,000 lin.ft. in New York, due to car shortage, labor and fuel situations.

Roads and Paving Materials—Mexican asphalt up $1 in bulk, f.o.b. Minneapolis and Baltimore; down $1 per ton in Atlanta. Package asphalt, Mexican, $18 as against $18.50, and bulk, $15.50 as compared with $16.50 f.o.b. Maurer, N. J., one month ago. Paving stone up 10c. in Atlanta; down 25c. per sq.yd. in St. Louis. Wood blocks cheaper in Philadelphia, St. Louis and New Orleans; up in Cincinnati and Kansas City. Demand heavy in Philadelphia; light in New Orleans.

Sand, Gravel and Crushed Stone—Sand advanced 5c. per cu.yd. in Philadelphia, 10c. in St. Louis and 20c. in Atlanta. Gravel up 10c. in Philadelphia and 15c. in Atlanta and St. Louis. Cincinnati reports drop in sand and gravel. Crushed stone higher in Philadelphia and St. Louis; down in Baltimore Cincinnati and Montreal. Fluctuations in this group due to local labor and transportation conditions.

Lime—Hydrated finishing lime up $6 in Baltimore, with slight rise in Atlanta; down $2 in St. Louis and $1 per ton in Cincinnati. Hydrated common, up $2.75 in Baltimore; down $3 per ton in St. Louis, with slight drop in Cincinnati. Lump finishing lime advanced 25c. per bbl. in Atlanta. Common lump dropped $1.75 per ton in Cincinnati and rose 5c. per bbl. (180-lb. net) in Atlanta. Advances due to fuel difficulties.

Cement—Mill advances of 25c. per bbl. at Hudson, N. Y., and Northampton, Pa. Other mill advances anticipated, owing to car situation. Mill rise reflected in following advances; f.o.b., Atlanta, 4c.; New Orleans, 10c.; St. Louis, 15c.; New York, 25c.; Birmingham, 30c. and Baltimore, 40c. per bbl.

Structural Steel—Shapes and bars up 10c. at Pittsburgh mill and in New York warehouses, during month; stiff advances at Birmingham. Demand for structurals light; $2@$2.15 quoted, with occasional small lots at $2.25 per 100 lb., f.o.b. Pittsburgh. Shortage of steel bars. Few mills taking on new steel business except on indefinite delivery basis. Rivets quoted at $3 as against $2.65 per 100 lb., f.o.b. mill; rise reflected in advances in San Francisco and St. Louis warehouses.

Steel Sheets—Blue annealed, base size, up 15c.; galvanized, 25c. per 100 lb. at mill; no change in black during month. Blue annealed advanced 16c., black and galvanized, 30c., in New York warehouses; both black and galvanized higher in San Francisco.

Brick and Hollow Tile—Common brick quoted at $15@$17 as against $18@$20 per M. alongside dock, New York. Price tendency downward, despite large amount of brick construction under way in New York City at present time. Brick down $2 per M. in Kansas City. Other cities show rising tendencies. New Orleans advanced $2.75; Cincinnati, $2; Atlanta, $1 and Birmingham, 50c. per M., during month. Hollow tile up in New York, St. Louis, Cincinnati, Detroit and Birmingham; down in Kansas City, Denver and Montreal.

Lumber—Market stronger, with no sign of slackening in demand. Car shortage holding up mill shipments. Yellow pine up $3 in New York; Douglas fir, $2 per M. ft. b.m. in San Francisco. Advances ranging from $1 to $5 per M. ft. in pine, fir, hemlock and spruce in Baltimore, Cincinnati, Seattle, St. Louis and Atlanta. Birmingham reports drop of $4 per M ft. in 1-in and 8-in. yellow pine.

Scrap—Rise of $1@$3 per gross ton in iron and steel scrap in New York; stiff advances in St. Louis during month. Demand due to pig-iron shortage.

Explosives—Average drop of 2c. per lb. throughout country on 40@60 per cent gelatin dynamite.

Linseed Oil—Quotations unchanged in New York during month; down 2c. per gal. in Chicago. Prices fairly stable despite scarcity of spot oil.

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton—Quotations compiled by The Matthew Addy Co.:

	Current	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	**$30.55**	$24.50
Northern Basic	**32.27**	22.52
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	**34.27**	23.52
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	**36.27**	30.26
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	**27.50**	20.00
PHILADELPHIA		
Eastern Pa., No. 2X, (2.25@2.75 sil.)	**36.64**	22.76
Virginia No. 2 (silicon 2.25 @ 2.75)	**37.17**	28.74
Basic	**34.00**	20.75
Gray Forge	**33.00**	21.75
CHICAGO		
No. 2 Foundry Local (silicon 1.75 @ 2.25)	**32.00**	22.70
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	**31.50**	26.66
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	**35.00**	22.96
Basic	**32.50**	21.96
Bessemer	**33.00**	21.96

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh Current	Pittsburgh One Year Ago	Birmingham	Chicago
Standard bessemer rails	**$43.00**	$45.00	.....	**$43.00**
Standard openhearth rails	**43.00**	47.00	**$43.00**	**43.00**
Light rails, 8 to 10 lb.	**45.00**	45.00	**1.80***	**43.00**
Light rails, 12 to 14 lb.	**45.00**	45.00	**1.80***	**43.00**
Light rails, 25 to 45 lb.	**45.00**	40.00	**1.80***	**43.00**
Rerolled Rails	**26@29**	.....	.....	.....

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	**$1.40**	**$1.55**
Chicago, Hardwood and Red Oak	**1.25**	**1.40**
Chicago....Empty Cell Creosoting (add'l)	.45	.50
San Francisco..... Green Douglas Fir	**.92**	**1.19**
San Francisco, Empty Cell Creosoted. Douglas Fir	**1.93**	**2.39**
St. Louis, Red Oak*	**1.30**	**1.60**
St. Louis (creosoted) (zinc treated)	**1.65**	**2.00**

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh Current	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ½-in. and larger	**$2.75@2.85**	$3.00	$2.55	*$2.85*	**$4.45**	**$3.29**
Track bolts	**3.75@4.50**	4.00	3.65	*3.85*	**5.45**	**4.29**
Standard section angle bars	2.40	2.75	2.40	*2.75*	**4.10**	*2.94*

PIPE

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	68	56½	⅜ to 1¼	**34**	**19**

LAP WELD

2	61	49½	2	**29**	**15**
2½ to 6	65	33½	2½ to 4	**32½**	**19**
7 to 8	62	49½	4½ to 6	**32½**	**19**
9 to 12	61	48½	7 to 12	**30**	**17**

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	66	55½	⅜ to 1¼	**34**	**20**
2 to 3	67	56½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	59	48½	2	**30**	**17**
2½ to 4	63	52½	2½ to 4	**33**	**21**
4½ to 6	62	51½	4½ to 6	**32**	**20**
7 to 8	58	45½	7 to 8	**25**	**13**
9 to 12	52	39½	9 to 12	**20**	**8**

STEEL PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black New York	Black Chicago	Black St. Louis
1 to 3 in. butt welded	60%	62½%	61½%
2½ to 6 in. lap welded	57%	59½%	58½%

	Galvanized New York	Galvanized Chicago	Galvanized St. Louis
1 to 3 in. butt welded	47%	48½%	51½%
2½ to 6 in. lap welded	44%	45½%	50½%

Malleable fittings, Class B and C, from New York stock sell at list less 10%. Cast iron, standard sizes, *32-5%* off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham Mill	New York Current	New York One Year Ago	Chicago	St. Louis	San Francisco
4 in.	**$45.00**	60.30	$50.30	**$52.70**	$44.50	$55.00
6 in. and over	**40.50**	55.30	45.30	**48.70**	.....	51.00

Gas pipe and Class "A," $4 per ton extra; 16-ft. lengths, $1 per ton.

CLAY DRAIN TILE—The following prices are per 1000 lin.ft.:

Size, In.	New York Current	New York One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	**$45.00**	$40.00	$40.00	$50.00	.....	$55.00
4	**55.00**	50.00	*50.00*	60.00	$76.50	65.00
5	80.00	80.00	70.00	80.00	97.75	84.00
6	**105.00**	105.00	*70.00*	100.00	127.50	110.00
8	**170.00**	175.00	*170.00*	150.00	212.50	181.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	$0.14	**$0.105**	.....	.....	$0.12	$0.12	.....
4	.14	**.105**	**$0.10**	$0.0875	.12	.15	$0.18
5	.20	**.1575**	**.125**	.1225	.18	.18	.165
6	.20	**.1575**	**.150**	**.1600**	.18	.21	.26
8	.34	**.245**	**.225**	**.2350**	.28	.30	.35
10	.51	**.3675**	.2925	**.3290**	.42	.42	.....
12	.65	**.4725**	.3825	**.4230**	.54	.54	.80
15	1.03†	**.63**	.5625	**.7050**	.72	.90	.....
18	1.50†	**.875**	.765	**.9870**	1.00	1.32	.....
20	1.80†	**1.05**	1.0125	**1.3160**	1.20	.....	.....
22	2.40†	**1.40**	1.2375	.....	1.60	.....	.....
24	2.70†	**1.575**	1.4625	**1.6920**	1.80	2.16	2.40
27	4.50†	**2.795**	.....	**2.5000**	3.75†	3.00	.....
30	5.00†	**3.096**	.....	**3.1000**	4.75†	3.60	.....
33	6.50†	**4.14**	.....	**3.3500**	5.50†	.....	.....
36	7.50†	**4.715**	.....	**3.6500**	6.00†	.....	.....
	3		5	8	12	24	36
Boston	$0.105		$0.1575	$0.245	$0.4725	$1.575	$4.408
Minneapolis	.....		.....	.40	.72	2.55	5.66†
Denver	.135*		.18*	.27	.47	1.70	.....
Seattle	.13		.....	.325	.65†	2.34†	.....
Los Angeles	.11*		.165*	.275	.495	1.65	.....
New Orleans	.106*		.159*	.27	.459	1.755†	.....
Cincinnati	**.111***		**.1665**	**.259**	**.4995**	**1.665**	3.7925†
Atlanta	**.10***		**.14***	**.225**	**.425**	**1.55**	.....
Montreal, *delivered*	.68‡		.45†	.70	1.35	4.50†	.....
Detroit	.102		.153	.238	.459	1.98†	6.15†
Baltimore	.1225		.2275	.35	.6870	2.29	5.23
Kansas City, Mo.	.135		.19	.30	.54	2.16	.....
Philadelphia	.114		.171	.266	.513	1.71†	3.895†

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

	Current	One Year Ago
New York, 45% asphalt.....(at terminal)	$0.05½	$0.05
New York, 65% asphalt.....(at terminal)	.05½	.05
New York, binder.....(at terminal)	.06½	.06
New York, flux.....(at terminal)	.06	.05½
New York, liquid asphalt....(at terminal)	.06½	.06½
St. Louis, 22@25% asphalt (*f.o.b.) Wood River, Ill.*	*.03½*	*.01½**
Chicago, 40-50% asphalt	.05½	.05
Chicago, 60-70% asphalt	.05½	.05½
Dallas, 40-50% asphalt	.10	.10
Dallas, 60-70% asphalt	.13	.13
Dallas, 75-90% asphalt	.15	.15
San Francisco, binder, per ton	13.00†	15.00

* Freight $21.75 per ton to Whiting, Ind.
† F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbl. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Mexican*)	$20.00	$14.00
Boston (*Mexican*)	19.50	16.00
Chicago (*Standard*)	20.35	14.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	19.50*	13.00*
Dallas, (*Texas*)	35.00	27.00
Seattle "*D*" *grade* (*California*)	23.75	13.00†
Denver (*California*)	40.00	
Minneapolis *f.o.b. Twin Cities* (*Mexican*)	33.50	**29.00**
St. Louis (*Mexican*)	30.00	25.00
Baltimore (*Mexican*)	18.00	**15.00**
Los Angeles, *at factory*, *Bakersfield* (*California*)	22.50	15.00
Montreal (*Mexican*)	28.00	21.00
Atlanta (*Mexican*)	22.00	*16.50*
Detroit (*Mexican*)	22.50	19.50
Cincinnati (*Mexican*)	22.50	19.50
Maurer, N. J. (*Trinidad and Bermudez*)	28.50	26.50
Maurer, N. J. (*Mexican*)	*18.00*	*15.50*
Philadelphia (*Mexican*)	18@20	15.00
Kansas City, *petroleum*	28.83	22.83

*Freight to San Francisco, 80c. per ton.

†F.o.b. Richmond, Cal.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums. Rebates of about $1 per bbl., no rebate for drums.

PAVING STONE—

New York *delivered*	5-in granite, 28@29 blocks per sq.yd.	$135.00 per M
Chicago	About 4x8x4 dressed	**3.35** sq.yd.
	About 4x8x4 common	**3.10** sq.yd.
San Francisco	Basalt block 4x7x8	70.00 per M
Boston	5-in. granite	no report
Atlanta	Granite	**2.10** sq.yd.
Detroit	Granite, 26½ blocks per sq.yd.	100.00 per M
Baltimore	Granite	2.00 sq.yd.
Montreal *delivered*	Granite	100.00 per M
New Orleans	Granite, 4 x 8 x 4	3.25 sq.yd.
Cincinnati	Granite	3.84@4 sq.yd.
St. Louis	4x8x4 dressed	*3.10* sq.yd.
	4x8x4 common	*2.90* sq.yd.
Kansas City	No. Granite	3.95 sq.yd.
Philadelphia	Granite	128.00 per M.

FLAGGING—

New York	Bronx, 5 ft.	$0.30@35	sq.ft.
	Manhattan, 4 ft.	.26	sq.ft.
	Queens, 5 ft.	.26	sq.ft.
	6x20-in. cross-walk	1.00	lin.ft.
Chicago	18 in. wide	.99	lin.ft.

CURBING—Bluestone per lineal foot, in New York, costs 77c.@85c. for 5x16 in., 88c. for 5x18 in., in cargo lots. 5x18 in., 72c. per lin.ft. delivered in St. Louis. 6x18 in., Chicago, $2 per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York (*delivered*)	3	16	$2.09
New York (*delivered*)	3½	16	2.29
New York (*delivered*)	4	16	2.57
Boston	3½	16	2.32
Chicago	4	16	3.00@3.25
Chicago	3½	16	2.50
St. Louis	3½	16	*2.00*
St. Louis	4	16	*2.00*
Seattle	4	16	Off market
Minneapolis	3½	16	2.09
Atlanta	3½	16	2.30
New Orleans	3	16	*1.70*
New Orleans	3½	16	*1.95*
New Orleans	4	16	2.25
Dallas	4	18	3.90
Baltimore	3½	16	3.44
Montreal	4	16	4.50
Detroit	3	16	2.84
Detroit	4	16	3.00
Cincinnati	4	16	**2.35**
Kansas City	4	16	**3.25**
Philadelphia	3½	16	*3.00*

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In. Current	Gravel 1½ In. One Year Ago	Gravel ¾ In. Current	Gravel ¾ In. One Year Ago	Sand Current	Sand One Year Ago
New York	$1.75	$2.00	$1.75	$2.00	$1.00	$1.25
Denver	1.75	2.00	1.75	1.80	0.75†	1.60
Chicago	2.00	1.75	2.00	1.75	2.00	1.75
St. Louis, *per ton*	**1.40**	1.35	**1.45**	1.40	**1.20**	1.40*
Seattle	1.00	1.50	1.00	1.50	1.00	1.50
Dallas	2.25	3.09	2.25	3.50	2.25	2.50
Minneapolis	1.75	2.00	1.75	....	1.00	1.00
Cincinnati	*1.40*	2.17½	*1.40*	2.36½	*1.15*	1.75½
San Francisco	2.25	2.25	2.25	2.50	1.50	1.50
Boston	....	2.65	....	2.65	....	2.00
New Orleans	2.85	2.85	2.85	....	1.35	1.35
Los Angeles, per ton	1.50†	1.35†	1.50†	1.35†	1.35†	1.20†
Atlanta, per ton	**2.00**	2.13	**2.00**	2.13	**1.35**	1.35
Detroit	2.00	2.00	2.00	2.00	2.00	2.00
Baltimore, per ton	1.40	1.40	1.60	1.60	0.70‡	2.40
Montreal, per ton	1.25	1.25	1.50	1.25	1.25	1.25
Birmingham, per ton (Crushed slag used instead of gravel)					*1.20*	1.37
Philadelphia	**1.70**	....	**1.75**	....	**1.65**	....
Kansas City, per ton	2.00‡	....	2.00‡	....	0.66†	....

* Fine white sand: Pacific, $5 per ton; Ottawa, $6.

Los Angeles—Freight from quarry, 85c. per ton, and is included in above price

† At pit.

‡ Per cu. yd.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless stated otherwise, is as follows, per cu.yd.:

	1½ In. Current	1½ In. One Year Ago	¾ In. Current	¾ In. One Year Ago
New York	$1.65	$1.80@1.90	$1.75	$1.80@1.90
Chicago	1.60	1.75	1.60	1.75
St. Louis *delivered*	**2.10**	1.65*	**2.20**	1.65*
Dallas	1.65	2.80	1.65	2.80
San Francisco	2.25	2.25	2.25	2.50
Boston, *delivered*		3.00*		3.00*
Minneapolis, *at plant*	2.00	2.00	2.25	2.25
Kansas City	2.00	1.50	2.50	1.50
Denver	3.50		3.50	
Seattle *delivered*	3.00	3.00	3.00	3.00
Atlanta	1.90*	2.25*	1.90*	2.25*
Cincinnati *delivered*	1.55*	2.68½	*1.55**	2.06½
Los Angeles	1.75*	1.60*	1.85*	1.70*
Detroit	1.90*	1.90*	1.90*	1.90*
Baltimore	*1.70**	1.75*	*1.60**	1.65*
Montreal	1.50*	2.00*	*1.90**	2.10*
Birmingham *delivered*	3.20	3.20	3.10	3.10
Philadelphia	**1.75***	....	**1.60***	....
Pittsburgh	2.85	....	2.85	....
Cleveland	3.00*	....	3.00*	....

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.30	$2.00	$1.30
Steubenville District	1.40	1.40	2.00	1.40
Ironton District	1.40	1.40	2.00	1.40
East Canaan, Conn.	1.25	1.35	4.00	1.00
Easton, Catasaqua, Pa.	1.00	1.00	2.00	0.90
Birmingham, Ala.	0.75	0.75	0.75	0.25
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.20	1.20	....	1.00
Eastern Pennsylvania and Northern New Jersey	1.20	1.20	2.00	1.20
Western Pennsylvania	1.25	1.25	2.00	1.25

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$15.80@$16.17	$13.10	$3.63½*	$2.75@$3.14†*
Chicago	18.00	....	....	1.40†
St. Louis	*21.00*	*17.00*	2.40†	2.25†
Boston	....	....	....	....
Dallas	25.00	....	....	2.50†
Cincinnati	*14.80*	*12.30*	....	*10.75‡*
San Francisco	22.00	16.00	....	1.75†
Minneapolis	29.00	22.00 (white)	1.70†	1.40†
Denver	24.00	....	....	2.70†
Detroit	18.00	16.00	....	17.00‡
Seattle *paper sacks*	24.00	....	2.80†	....
Los Angeles	30.00	30.00	3.00*	3.00*
Baltimore	**21.00**	**15.75**	....	12.00‡
Montreal	21.00	21.00	15.00‡	11.00‡
Atlanta	**23.00**	13.00	**2.25†**	**1.80†**
New Orleans	....	17.25	2.40†	....
Philadelphia	15.00	14.00	12.50‡	11.50‡
Kansas City	25.60	24.00	2.34†	*2.22†*

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl. Minneapolis quotes brown common lump lime; Kelly Is, white is $1.70, Sheboygan $1.55. New York quotes hydrated lime "on cars" in paper sacks; lump lime "alongside dealers docks" or "on cars."

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b., exclusive of bags:

	Current	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	**1.75**	1.60
Atlanta (Magnolia)	11.00	11.00
Cincinnati (Utica)	*1.72*	1.77
Boston (Rosendale) per bag	....	0.95@1.05
St. Louis (Carney)	*1.87*	....

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Current	One Month Ago	One Year Ago
New York, del. by truck	**$2.60@2.75**	$2.60	$2.50
New York, alongside dock to dealers	**2.55**	2.30	2.10
Jersey City	2.73	2.73	2.60
Boston	....	....	2.61
Chicago	2.20	2.20	1.97
Pittsburgh	2.24	2.24	2.02
Cleveland	2.46	2.46	2.28
Detroit	2.48	2.48	2.31
Indianapolis	2.41	2.41	2.23
Toledo	2.53	2.53	2.31
Milwaukee	2.37	2.37	2.19
Duluth	2.14	2.14	1.95
Peoria	2.41	2.41	2.14
Cedar Rapids	2.48	2.48	2.28
Davenport	2.43	2.43	2.22
St. Louis	**2.35**	2.20	2.90
San Francisco	2.71	2.71	2.84
New Orleans	**3.30**	3.20	3.20
Minneapolis	2.39	2.39	2.26
Denver	2.85	2.85	3.10
Seattle	2.90	2.90	3.10
Dallas	2.25	2.25	2.55
Atlanta	**2.54**	2.50	2.69
Cincinnati	2.59	2.59	2.37
Los Angeles	3.30	3.30	3.31
Baltimore, del. by truck	**2.90**	2.50	2.88
Birmingham	**2.40**	2.10	2.85
Kansas City	2.85	2.85	2.80
Montreal	2.78	2.78	2.75
Philadelphia	2.41	2.41	....
St. Paul	2.39	2.39	2.26

NOTE—Bags 10c. each, 40c. per bbl.;

Current mill-prices per barrel in carload lots, without bags; to contractors:

Buffington, Ind.	$1.95	Mason City, Ia.	**$2.35**
Universal, Pa.	2.00	La Salle, Ind.	2.35
Steelton, Minn.	1.95	Hudson, N. Y.	**2.35**
Fordwick, Va.	2.35	Leeds, Ala.	**2.10**
Mitchell, Ind.	2.35	Hannibal, Mo.	**2.00**
Iola, Kan.	2.10	Lehigh Valley District	**2.25**

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq ft.	Pittsburgh, Mill	Warehouse: New York	Chicago	Dallas	San Francisco
032	22	$0 74	$0.95	$0 86	$1 15	$1 20
049	28	94	1.23	1 11	1 46	1 55
068	35	1 14	1 48	1 35	1 80	1 89
093	45	1 46	1 91	1 73	2 30	2 43
126	57	1 80	2 35	2 13	2 86	3 00
153	68	2 14	2 81	2 54	3 40	.....
180	78	2 46	3 22	2 92	3 93	.....
245	103	3 24	4 25	3 85	5 15	.....
287	119	3 75	4 90	4 45	5 96	6 31
336	138	4 35	5 69	5 16	7 32	.....
395	160	5 04	6 60	5 98	8 00	.....
		PAVING				
036P	17	$0.56	$0 72	$0 66	$0.88	.....
053P	24	.79	1 02	.93	1 24	.....
072P	31	.99	1 29	1 18	1 57	.....
097P	40	1.28	1 67	1 52	2 02	.....
049R	24	.79	1 02	.93	1 24	.....
067R	31	.99	1 29	1 18	1 57	.....
089R	40	1 28	1 67	1.52	2 02	.....

In rolls 16-, 20-, 24-, 28-, 32-, 36-, 40-, 44-, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in wide x 150 ft. long, or 600 sq. ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Gage	Weight	*New York	Chicago	St. Louis	San Francisco	Dallas
27Dia.	2.3	$22 00	$23 25	$23 00	$20 78	$25 50
26 "	2.5	22 00	24 75	25 00	21 43	27 56
25 "	3.0	22 00	27 25	*27 00*	.....	30 71
24 "	3.4	24 00	29 25	29 50	24 28	33 16
22 "	4.33	27 00	33 75	.....	.....	35 10

* Price to contractors at warehouse or delivered on job in Manhattan, Bronx or Brooklyn.

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$2 00@2 25	$2 20	$3 04	$2 92½	2 70	$3 50	$3 00
⅝	2 05@2 30	2 20	3 09	2 97½	2 75	3 55	3.05
¾	2 10@2 35	2 25	3 14	3 02½	2 80	3 60	3.10
⅞	2 25@2 50	2 25	3 19	3 17½	2 95	3 75	3 25
1	2 50@2 75	2 30	3 54	3 42½	3 20	4 00	3.50

Includes 15c charge for cutting to lengths of 2 ft. and over. Twisted bars cut to length take extra of 27½c. per 100 lb.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ and larger	$2 10	$2.55	$3 25	½	$2 35	$2 80	$3 50
⅝ in	2 15	2 60	3 30	¼	2 60	3 05	3 75
¾	2 20	2 65	3 35	.....	.....	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Current*	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.)	*$18@20.20*	$21.30@23.50	$18.40@19.40	$42 00†	$50 00†
New York (at dock)	*15@17*	18@20	15@15 50	.....	.....
Chicago	11 00	11 00	11 00	34 00	42 00
St. Louis, salmon	14 00	14 00	17 00	35 00	**38 50**
Denver, salmon	12 00	12 00	14 00	.....	.....
Dallas	10 90	10 30	12 72	no market	
San Francisco	15 00	15 00	18 00	.....	.....
Los Angeles (del.)	15 00	15 00	15 50	(not used)	
Boston (del.)	.....	.....	17 00	44.00†	53 00†
Minneapolis (del.)	18@19	18@19	17.00	.....	43.00
Kansas City	*14 50*	16 50	14 50	.....	.....
Seattle	14 00	14 00	14 00	44.00	
Cincinnati	**17 00**	15 00	18.50	41.00	36.50
Montreal	16 00	16 00	16 00	.....	68.00
Detroit (del.)	16.50	16 50	17 00	36 50	39 50@41
Baltimore (del)	20 00	20 00	20.00	36.00‡	.....
Atlanta	**12 00**	11 00	10.00	**39.00**	.....
New Orleans	**15 75**	13.00	14.00	.....	.....
Birmingham	**12 50**	12.00	11.50	.....	.....
Philadelphia	**19@24**	17.50@18.50	16.50@17.50	38.00	46.00
Pittsburgh (del.)	16.00	16.00	.....	.....	.....
Cleveland	16.00	16.00	.....	.....	.....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. † F.o.b. ‡ Vitrified, f.o.b. plant, Baltimore.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Current on Trucks*	One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12	**$0.1239**	$0.11370	$0.0808	$0.115	**$0 092**	$0.108	.....
6x12x12	**1844**	.15160	.1112	.....	**.115**	.156	.....
8x12x12	**2305**	.20210	.1516	.18	**160**	.244	**$0.2147**
10x12x12	.....	.....	.1879	.....	**.185**	.....	**2653**
12x12x12	.....	.....	.2147	.....	**220**	.....	**3448**

* 5 per. off for cash.

	4x12x12	8x12x12	12x12x12
Boston	.....	.....	.....
Minneapolis (f.o.b. cars)	$0 08	$0.13125	$0.23
Minneapolis (delivered)	09	.14675	.245
Cincinnati	**1093**	**1861**	.....
Kansas City	*.083*	*.1455*	.270
Denver	*.065*	*123*	*188*
Seattle (delivered)	11	.25	.36
Los Angeles factory	095	176	.22
New Orleans	12	23	.36
Detroit (delivered)	**09**	**175**	**260**
Montreal	*.08*	*.15*	*.29*
Baltimore	14	25	.39
Atlanta	.0776	.1453	.....
Dallas	115	.....	.....
Birmingham	**11**	**18**	.....
Pittsburgh (del.)	.068	.128	.179
Cleveland	08	164	.....

San Francisco, Philadelphia, Atlanta, New York and Chicago quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburg and Birmingham together with quotations per 100 lb. from warehouses at place named:

	Pittsburgh, Mill	Birmingham Mill	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	**2.00@2.25**	**$2 40**	**$3 14**	$4 20	$3.00	$2 92½	$3.25
Channel, 3 to 15 in.	**2.00@2.25**	**2 40**	**3 14**	4 20	3.00	2 92½	3 25
Angles, 3 to 6 in., ¼ in. thick	**2.00@2.25**	**2 40**	**3 14**	4 20	3.00	2 92½	3 25
Tees, 3 in. and larger	**2.00@2.25**	**2 40**	**3 14**	4 20	3.05	2 92½	3.25
Plates	**2.00@2.25**	**2 40**	**3 14**	4 20	3.00	2 92½	**3.40**

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh, Mill	Warehouse: New York, Current	New York, One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in. and larger	**$3.00**	$3.85	$4 40	$3 35	**$3 60**	**$4 50**	$6.00

CONE HEAD BOILER

½ in. and larger	**3 10**	3.95	4 50	3.45	**3.70**	**4 60**	6 15
⅝ and ¾	**3.25**	4.11	4 65	3.60	**3.70**	**4 75**	6 30
⅞ and 1	**3.50**	4.35	4 90	3.85	**3 70**	**5 00**	6.55

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in. take an extra of 25c.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	**$2.60@2 75**	$3 10	**$4 00**	$5 00	**$3.60**	$4 95
Cut	....	5 50	5.65	7 75	6.00	5 00

PREPARED ROOFINGS—Standard grade rubbered surface, complete with nails and cement, costs per square, f.o.b., as follows:

	New York: 1-Ply l.c.l.	2-Ply l.c.l.	3-Ply l.c.l.	Philadelphia: 1-Ply l.c.l.	2-Ply l.c.l.	3-Ply l.c.l.
No. 1 grade	$2 10	$2 55	$3.00	$1 90	$2 25	$2 80
No. 2 grade	1.85	2.15	2 55	1 70	2 00	2 40

Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $1.95 per roll in carload lots and $2.20 for smaller quantities f.o.b. Philadelphia.

Single shingles, red and green slate finish, cost $5.50 per package (sufficient to cover 50 sq.ft.) in carloads; $5.75 in smaller quantities, in Philadelphia. Strip shingles (4 in 1) f.o.b. Philadelphia. l.c.l., $5.90

ROOFING MATERIALS—Prices f.o.b. New York:

Tar felt (14 lb. per square of 100 sq.ft.) per roll of 432 sq.ft.	$2 06
Tar pitch (in 400-lb. bbl.), per 100 lb	1 65
Asphalt roofing (in barrels), per ton, f.o.b. plant*	40.50
Asphalt felt (light), per ton, f.o.b. plant*	64.50
Asphalt felt (heavy), per ton, f.o.b. plant*	68.50

* Delivered in Metropolitan Dist., $3.00 additional.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	**$2.50@$2.75**	4.10	$4.00	$4.35	**$4 19**
No. 12	**2.60@ 2.85**	4.15	4.05	4.40	**4 24**
No. 14	**2.70@ 2.90**	4.20	4.10	4.45	**4 29**
No. 16	**2.90@ 3.20**	4.30	4.20	4.55	**4.39**
Black					
*Nos. 18 and 20	3.20@ 3.35	4.65	..	**5 70**	**4 70**
*Nos. 22 and 24	3.25@ 3.40	4.70	4 70	**5 75**	**4 75**
*No. 26	3.30@ 3.45	4.75	4.75	**5 80**	**4 80**
*No. 28	3.35@ 3.50	4.85	4.85	**5.90**	**4 90**
Galvanized					
No. 10	3.35@ **3.75**	4.85	4.85	....	**4.90**
No. 12	3.45@ **3.85**	4.95	4.95	**5.85**	**5.00**
No. 14	3.45@ **3.85**	4.95	4.95	**5 85**	**5.00**
Nos. 17 to 21	3.75@ **4.15**	5.10	....	**6 15**	**5.30**
Nos. 22 and 24	3.90@ **4.30**	5.40	5.40	**6 30**	**5.45**
*Nos. 25 and 26	4.05@ **4.45**	5.55	5.55	**6 45**	**5.60**
*No. 28	4.35@ **4.75**	5.85	5.95	**6.75**	**5.90**

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Current	New York: One Year Ago	Chicago: Current	Chicago: One Year Ago
Raw in barrel (5 bbl. lots)	$0.91	$0 76	*$0 97*	**$0.87**

WHITE AND RED LEAD—Base price in cents per pound:

	Red				White	
	Current		1 Year Ago		Current	Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry or In Oil	Dry or In Oil
100-lb. keg	12 75	14 25	12 25	13 75	12 75	12 25
25 and 50-lb. kegs	13 00	14 50	12 50	14 00	13 00	12 50
12½-lb. keg	13 25	14 75	12 75	14 25	13 25	12 75
5-lb. cans	15 75	17 25	15 25	16 75	15 75	15 25
1-lb. cans	17 75	19 25	17 25	18 75	17 75	17 25

LUMBER

Prices wholesale to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M ft. additional.

	6–8 and 12 Ft.	10–16–18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$30 00	$33 00	$33 00	$35 00
3x6 and 8	30 00	33 00	33 00	36 00
4x4-6 and 8	30 00	33 00	34 00	37 00
3x10 and 12	30 00	35 00	34 00	38 00
3x14	34 00	35 00	36 00	38 00
4x10 and 12	30 00	33 00	34 00	37 00
4x14	34 00	35 00	36 00	38 00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft
6x10	$32 00	$35 00	$37 00
6x14	34 00	37 00	39 00
8x10	32 00	35 00	37 00
8x14	34 00	37 00	39 00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York*		Chicago	
	20 Ft. and Under	22–24 Ft.	20 Ft. and Under	22–24 Ft.
3x 4 to 8x8	$47 00	$48 00	$45 00	$47 00
3x10 to 10x10	50 00	51 00	48 00	50 00
3x12 to 12x12	54 00	55 00	51 00	53 00
3x14 to 14x14	60 00	61 00	56 00	58 00
3x16 to 16x16	67 00	68 00	60 00	62 00
3x18 to 18x18	80 00	81 00	67 00	69 00
4x20 to 20x20	90 00	91 00	77 00	79 00

*Wholesale price to dealers; to contractors, delivered from lighters or cars to job, $5 additional. Short leaf pine up to 14 x 14 costs $15 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12 x 12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under. For pine add $2 to the price of merchantable for all sizes.

Other Cities

	8 x 8-In. x 20 Ft. and Under				12 x 12-In. 20 Ft. and Under
	P.	Fir	Hemlock	Spruce	P.	Fir
Boston	.....	.....	.....	.....	.....	.....
Seattle	.....	$24 50	.....	.....	.....	$24 50
New Orleans	$30 00	.....	.....	.....	$35 00	.....
Baltimore	58 00	.....	.....	.....	70 00	.....
Cincinnati	40 00	.....	.....	.....	45 00	.....
Montreal	50.00	50 00	$35.00	$38.00	78.00	50.00
Los Angeles	.....	44 00	43.00	.....	.....	44.00
Denver	.....	38 75	38.75	38 75	.....	*39.75*
Minneapolis	47 00	*39.75*	42.00	.....	49.00	*39.75*
Atlanta	37 00	.....	.....	.....	42 00	.....
Dallas	37 50	.....	.....	.....	40.00	.....
Kansas City	47 00	47.00	47.00	49 50	49.00	.....
Birmingham	*28 00*	.....	.....	.....	36.00	.....
Philadelphia	39 00	*38.08*	45.00	50.00	48.00	40 00
Detroit	43 75	*45.75*	.....	.....	51.75	46.75
St. Louis	35.50	.....	.....	.....	39.50	.....

	1-In. Rough, 10 In. x 16 Ft.— and Under			2-In. T. and Gr. 10 In. x 16 Ft.
	P.	Fir	Hemlock	P.	Fir
Boston	.....	.....	.....	.....	.....
Seattle	.....	$20.00	.....	.....	$23.50
New Orleans, at mill	$70 00	.....	.....	$37.00	.....
Baltimore	40 00	.....	.....	40 00	.....
Cincinnati	65 00	80.00	.....	37.50	.....
Montreal	66.00	45.00	$27.00	45.00	45.00
Los Angeles	.....	37.00	36.00	.....	43.00
Denver	.....	*32.25*	*32.25*	.....	33.25
Minneapolis	46.50	40.25	38.25	43.75	40.25
Atlanta	24 00	.....	.....	28.00	.....
Dallas	37.50	30 00	.....	40.50	.....
Kansas City	*44.50*	38.50	38.50	*38.75*	40.00
Birmingham	*24 00*	.....	.....	30.00	.....
Philadelphia	33.00	38.50	45.00	35.00	38 00
Detroit	45.25	38.50	.....	42.00	41 00
St. Louis	68.00	.....	.....	45.00	.....

Montreal—Up to 32 ft.; over which, $3.00 per M. increase up to 30 ft.

Birmingham—Quotes carload lots, f.o.b. sidings. $2.00 additional per M. ft. to contractor.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers prices to contractor on large projects.

St. Louis—Wholesale price to contractors, $12@$14 per M ft. additional.

Seattle—Price to contractor, delivered.

FREIGHT RATES

On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.315	Detroit	$0.295
Birmingham	.69	Kansas City	.735
Boston	.365	New Orleans	.515
Buffalo	.265	New York	.34
Chicago	.34	Pacific Coast (all rail)	1.50†
Cincinnati	.295	Philadelphia	.325
Cleveland	.215	St. Louis	.43
Denver	1.275*	St. Paul	.595

* Minimum carload, 40,000 lb.

†Minimum carload, 50,000 lb., structural steel only; 80,000, lb. for other iron or steel products.

CONTRACTORS' SUPPLIES

STEEL SHEETPILING—The following price is base per 100 lb. f. o. b. Pittsburgh, with a comparison of a month and a year ago:

Current	One Month Ago	One Year Ago
$2.50	$2.35	$2.00

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Hercules red strand, all constructions	25%
Patent flattened strand, special and cast steel	25%
Patent flattened strand, iron rope	10%
Plow steel round strand rope	40%
Special steel round strand rope	35%
Cast steel round strand rope	27½%
Round strand iron and iron tiller	10%
Galvanized steel rigging and guy rope	12½%
Galvanized iron rigging and guy rope	+7½%

California, Oregon, Nevada and Washington Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¾-in., 8 ft., ½-in., 6; ¼-in., 4½; 1-in., 3½; 1½-in., 2 ft. 10 in.; 1¼-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston		New Orleans	$0.17½
New York	$0.17	Los Angeles	.16½
Chicago	.19	Seattle	.18
Minneapolis	.19½	St. Louis	.17½
San Francisco	.17	Montreal	.30
Atlanta	.20	Detroit	.19
Denver	.20	Baltimore	.17
Cincinnati	.19	Kansas City	.19½
Dallas	.29	Birmingham	.20½
Philadelphia	.18¼		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.30
Boston	.....	.....
Kansas City	*.2225*	*.2525*
Seattle	.175	.195
Chicago	.2450	.2750
Minneapolis	.2092	.2295
St. Louis	*.2425*	*.2725*
Denver	.2025	.2325
Dallas	.29	.375
Los Angeles	.23	.26
Atlanta	.2525	.2825
Baltimore	*.1950*	*.2250*
Cincinnati	*.2300*	*.25*
Montreal	.195	.235
Birmingham, *delivered*	*.19*	*.21*
New Orleans	*.2350*	*.2650*
San Francisco	.195	.235
Philadelphia	.24	.27

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.13	$0.17½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	0.17½	0.22
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	0.19½	0.24
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	0.23	0.32
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	0.25	0.34
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	0.32	0.38

SCRAP—The prices following are per gross ton paid to dealers and producers f.o.b. New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$14.50	$11.50	$15.00
Stove plate	13.50	12.00	15.00
No. 1 machinery cast	18.00	16.50	21.00
Machine shop turnings	9.00	4.00	10.00
Cast borings	12.00	5.50	11.50
Railroad malleable cast	15.00	12.50	19.00
Re-rolling rails	16.00	13.00	18.00
Relaying rails	28.50	30.00	23.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco Galv.	San Francisco Black	Seattle Black
½	$6.75	$5.50	$8.55
⅝	6.30	5.05	8.25
¾	6.15	4.90	8.30

Pittsburgh base in lots of 200 kegs or more $3.25@3.75.